2024

White Paper on China's RFID Passive Internet of Things Industry

Publishing institutions:

AIoT星图研究院 | 物联传媒 Ulink Media | SZIOT 深圳市物联网产业协会 SHENZHEN INTERNET OF THINGS INDUSTRY ASSOCIATION | AIoT库 www.iotku.com | IOTE 物联网展

Participating institutions:

Checkpoint | DASCOM | Kiloway 凯路威科技 | 先施科技 Sense Technology | ZSF | Pragmatic Semiconductor

Publishing institutions:

AIoT Xingtu Research Institute

Shenzhen IoT Industry Association

Shenzhen Ulinkmedia Co., ltd.

AIoTku

IOTE-IoT Expo China

Participating institutions:

Checkpoint Commercial (SHANGHAI) Co., Ltd.

Dascom

Sichuan Kailuwei Technology Co., Ltd

Sense Technology Co., Ltd

Guangdong Zhongshifa Intelligent Technology Co., Ltd

Pragmatic Semiconductor

Checkpoint

Checkpoint Systems, a division of CCL Industries, is a global leader in RFID/EAS-driven loss prevention, inventory control & traceability, branding, supply chain management and business data intelligence solutions. Its +50 years' expertise are behind its unique combination of cloud-based SaaS, connected hardware, labels and tags offering intelligent solutions that bring clarity and efficiency to companies, from source to shop.
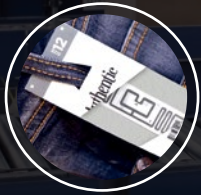
RFID Label   RFID Hardware   RFID Software & Data Analysis

DASCOM

🏢 INTRODUCTION

Established in 1988, DASCOM Group is a comprehensive high-tech group, having a R&D center and factory at Jiangmen China. As a printing solutions provider, with a heritage of physical and intellectual capacity, and advanced research, design, and manufacturing, DASCOM Group provides customized solutions to fulfill diverse printing requirements of customers.

DASCOM Group supplies complete range of hardware devices, including RFID printers, smart cabinets, channel machines, access controls, PDAs and more, for the IoT industry, and offers supporting solutions for asset, archive, warehousing and supply chain management systems.

DASCOM Group has considerable project experience in logistics and expresses, public service, healthcare, industrial manufacturing, finance and other sectors.

Kiloway
凯路威科技

Provider of patented X-RFID® tag chip and IOT accurate identification solution

www.kiloway.com
400-0550-570

Kiloway
Official Account

RFID: connect the world invisiblly

Medicine

Apparels | **Retail**

Air luggage sorting | **Logistics**

Archives/ Books

STICK HERE

Being for digital world & smart life
◎ Massive disposable application
◎ Complex Scenario Application

RFID Tag Chip *Neuron of IOT*

Product List

Sichuan Kiloway Technologies Co., Ltd.

Kiloway is one of the earliest companies to independently develop passive RFID tag chips in China. The patented XLPM (Super Low-power Permanent Memory) technology of Kiloway enables the X-RFID® tag chip to have the dual-attribute advantages of extreme performance and extreme cost. For the ultra-low cost requirements of massive applications, as well as the technical challenges of complex scene applications, the X-RFID® tag chip always stay ahead.

X-RFID® tag chip products, using the standard Logic CMOS process, have the unique advantages of "4H1L" (high performance, high efficiency, high reliability, high yield, low cost), excellent environmental adaptability, ultra-long data retention, excellent performance in various complex application scenarios. Kiloway's RFID tag chips cover UHF RFID (ISO18000-6C), HF RFID (ISO15693/14443A) frequency bands, and the product is widely used in apparels, logistics, retail, air luggage sorting, medicine, asset management, intelligent manufacturing, smart agriculture, anti-counterfeiting traceability and other fields.

Light up the target

2 billion⁺ *product shipments*

Create **100 billion** *market*

Detect the changes

X-RFID® tag chip: high performance, high efficiency, high reliability, high yield, low cost

IOT accurate identification solution: precision identify and determine

---

先施科技
SENSE Sense Technology

SENSE TECHNOLOGY CO.,LTD.

· National-level "Specialized, Refined, Unique, and New" little giant.
· Well-known Chinese supplier of IoT RFID products and solutions.
· "Outstanding Product and Application Award in the Chinese RFID Industry Evaluation" – consecutively won for 20 years.

Independent intellectual property rights / Unique innovation / Internet of Things technology application products

· "SENSE-S800 Product Manufacturing History RFID Intelligent Operation Management System"
· "SENSE-C2000 Self-service RFID Intelligent Cabinet Management System for Tools and Items"
· "SENSE-S100 Digital Management System for Retail Stores"
· "SENSE-WMS600 RFID Intelligent Warehouse Management System"
· "SENSE-AMS3 RFID Asset Digital Management System"
· "SENSE-E100 Sense Intelligent Edge Computing Platform"

Sense Technology was established in 2001. It is a leading enterprise in China's Internet of Things RFID industry. It has more than 100 core patented technologies for RFID products and a number of provincial and ministerial scientific and technological achievements. It is an excellent team in the implementation of major scientific and technological projects of the Ministry of Science and Technology.

Sense Technology has been deeply involved in the field of industrial digital applications for many years. And it has established an industrial digital technology innovation center at its Shenzhen headquarters. It focuses on product research and development and application systems in the field of industrial digitalization. It has a number of core patented technologies and has been successfully applied in world-class enterprises such as BMW, Haier, Huawei, SF Express, Postal Service, and TCL.

· Shenzhen Sense Headquarters

Contact us

Contact: Miss Wang
Tel: 0755-88833238/18025394822
Website: www.sense-hk.com
Address: 22-24th Floor, Building B, Wisdom Plaza, No. 4068 Qiaoxiang Road, Nanshan District, Shenzhen

· Sense Technology - Industrial Digital Innovation Center (integrating technology research and development, display, experience, learning and communication)

Invengo

Boosting IoT Enjoying Life

The global leading RFID and IOT solution provider.

About Invengo

Shenzhen Invengo Information Technology Co., Ltd. (stock code: 002161) was founded in December 1999. In August 2007, it was listed on the Shenzhen Stock Exchange. It is a representative enterprise in China's Internet of Things industry and the first domestic listed company in the RFID field. The company is dedicated to researching and developing core technologies and solutions for RFID and the Internet of Things. It has over 100 products of its own research and development, including RFID chips, electronic tags, readers, and handheld devices. It has accumulated more than 600 authorized patents and proprietary technologies. In the Internet of Things industry, Invengo focuses on three major businesses: railways, smart culture, and apparel retail. At the same time, it vigorously develops vertical application fields of RFID Internet of Things in emerging industries such as smart healthcare, smart power, tobacco and alcohol management, and others, providing high-performance RFID technologies, products, and overall solutions.

Intelligent Hardware Products

| Electronic tag | Antenna | Handheld | Fixed reader |

Application Platform

| Equipment management platform | Access management platform | Application development platform | Business analysis platform |

Application Field

- Rail transit
- Libraries and urban Study Rooms
- Tourism and cultural creativity
- Archives warehouses
- Retail stores
- Tobacco and alcohol management
- Power grids
- Smart healthcare

Industry solutions

- Railway transportation management solution
- Smart library solution
- Smart city study room solution
- Smart archives warehouse solution
- Smart tourism solution
- Garment retailing solution
- Digital warehousing solution
- Power asset management solution
- Tool management solution
- Refined drug management solution
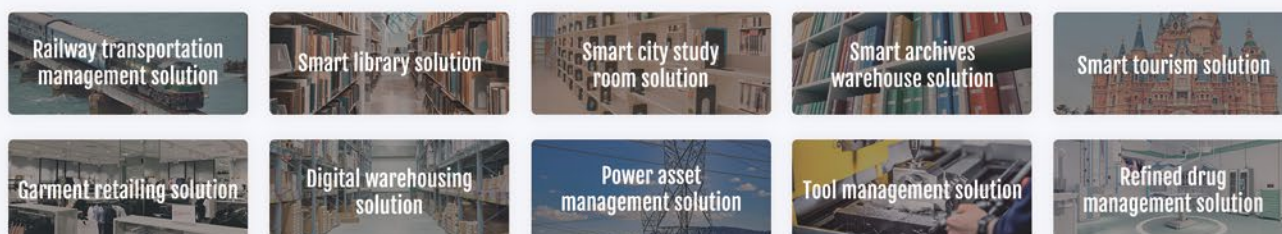
Shenzhen Xinjinglu Electronic Technology Co., Ltd.

China leading manufacturer of electronic tag production equipment

RFID Flip-Chip Machine

XJL-TTA-4

XJL-TTA-2

XJL-TTA

DZJ-10000

RFID Converting Machine

FH-40000 D

FH-10000 D

Company Profile

Shenzhen Xinjinglu Electronic Technology Co., Ltd. was established in 2008 and is a high–tech enterprise specializing in the production of electronic tags (RFID) equipment, integrating research and development, production, sales, and maintenance. Shenzhen Xinjinglu Electronic Technology Co., Ltd. is one of the few domestic suppliers of electronic label (RFID) production equipment, and is the driving force at the source of the RFID industry chain, playing an important role in promoting the development of the entire RFID industry in China.

From 2010 to 2013, the company completed the development and improvement of the entire automatic production line equipment for electronic tags (RFID). Shenzhen Xinjinglu Electronic Technology Co., Ltd. has also become the first supplier in China to provide a complete set of production equipment for electronic labels, including RFID flip–chip machines, RFID converting machines, and RFID testing machines. The company has also become a leader in domestic RFID equipment and break the long–term monopoly trend of foreign equipment in this industry. The equipment developed by the company fully possesses independent intellectual property rights and has obtained national patents. It is characterized by high technological content, precise equipment craftsmanship, small size, high efficiency, easy maintenance, and low power consumption. In order to improve service quality, our company has conducted systematic training for sales and customer service personnel, striving to provide professional services to customers. At the same time, we can also provide customers with solutions such as product design processes, inlay laminating, and electronic label production processes.

Company address: 2–3 Floor, A Building, Fucheng Kechuang Mansion, No.9 Fuhua Road, Fumin community, Fucheng Sub–district, Longhua District, Shenzhen, China
Tel：0755–82535678 / 82535679   Fax：0755–82535675
E–mail：sxlwillxie@163.com   Website：http://www.xinjinglu.com

中科长光精拓
INFINITECH

+86 139 1782 1377 (Mr. Dong)
+86 139 1822 3976 (Mr. Gu)

A research and manufacturing center for advanced packaging and testing equipment for semiconductor integrated circuits
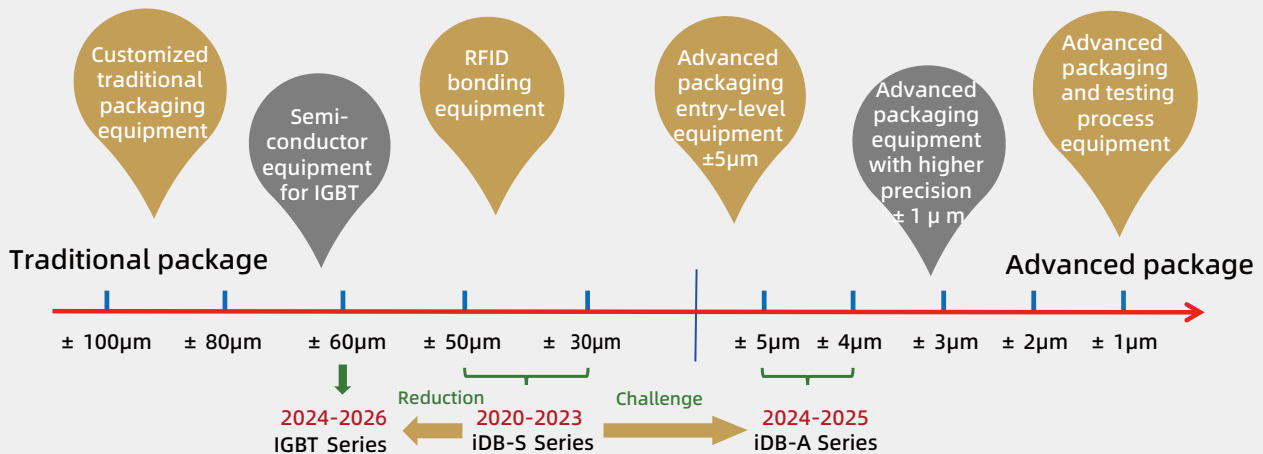
Infinitech Automation (SUZHOU) Co.,Ltd.

Infinitech Automation (SUZHOU) Co.,Ltd. is a high-tech enterprise, focusing on the research, manufacturing and sales of advanced packaging and testing equipment for semiconductor integrated circuits. With years of deep cultivation in the field of high-end semiconductor integrated circuits technology, we have accumulated and mastered chip level packaging and testing equipment technology, processes and markets.

Small Die/ Green Technology Antenna

23+ Patents for Inventions

iDB-S: RFID Inlay Bonding and Testing

No.	Equment Series	Industry affiliation	Specification	Applications	Benchmark	Remarks
1	iDB‑S (single row)	Packaging & testing of RFID components	50μm /17000uph	RFID inlay bonding and testing	Mühlbauer	Launched in June 2023
2	iDB‑S Plus (single row)		50μm /22000uph		Mühlbauer	Launched in August 2024
3	iDB‑RD (dual row)		50μm /45000uph		Mühlbauer	Launch at the beginning of 2025
4	iDB‑RT(single row/ high temperature version)		30μm/>30000uph		Nexperia	Launched in mid‑2025
5	iDB‑Advanced	Advanced packaging and testing equipment for semiconductor integrated circuits	5μm /5000uph	chiplet Multidimensional differentiationConstruct (fan out/2.5D/3.0D)	Besi	Launched in 2025
6	iDB‑X Series	Traditional packaging and testing equipment for semiconductor integrated circuits	70μm	New energy vehicle electronics/ IGBT in energy storage and other fields Advanced packaging and testing of electronic components(Newprocess)	/	Launch in 2025
7	iDB‑RT(single row/ low temperature version)	Packaging & testing of Semiconductor RF components	30μm/>40000uph	RFID inlay bonding and testing	/	Launch in 2026

Customized traditional packaging equipment

Semi‑conductor equipment for IGBT

RFID bonding equipment

Advanced packaging entry‑level equipment ±5μm

Advanced packaging equipment with higher precision ±1μm

Advanced packaging and testing process equipment

Traditional package

Advanced package

± 100μm ± 80μm ± 60μm ± 50μm ± 30μm ± 5μm ± 4μm ± 3μm ± 2μm ± 1μm

Reduction

Challenge

2024-2026 IGBT Series

2020-2023 iDB‑S Series

2024-2025 iDB‑A Series

AGIC IOTE® 物联网展

May Barcelona

Jun Shanghai
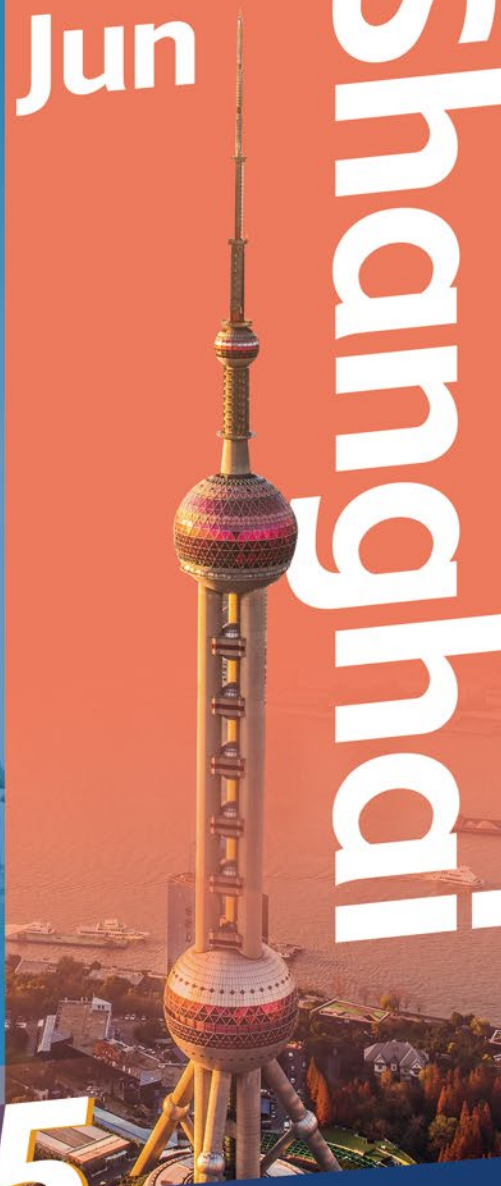
Aug Shenzhen
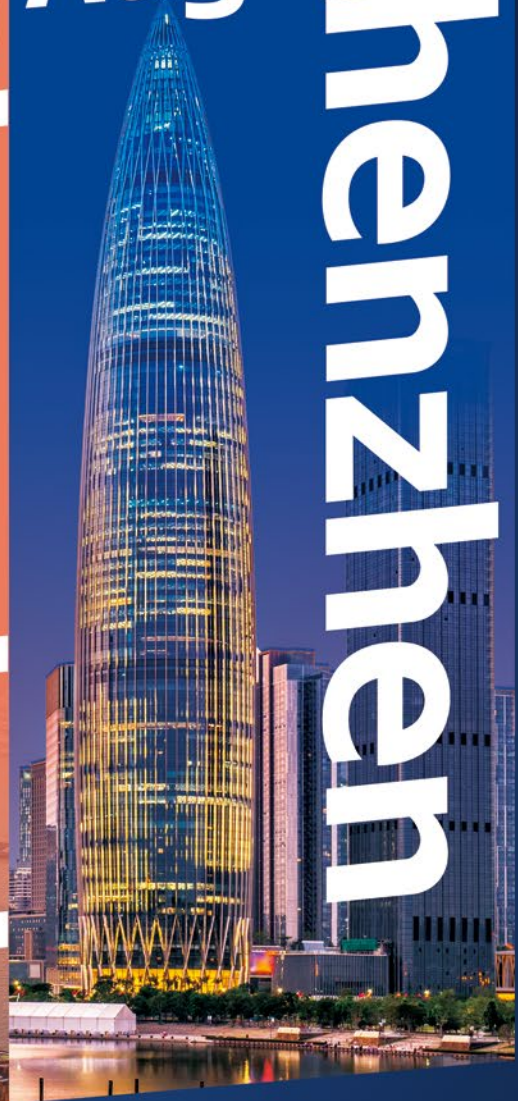
2025
AIoT Global Tour !

BOOTH RESERVATION Mr. Chen
86-18676385933

About AIOT Star Chart Research Institute

AIoT Xingtu Research Institute is a market research organization focusing on the field of Internet of Things. Based on the business information of first-line AIoT enterprises, it is committed to outputting the complex Internet of Things industry into concise and clear visual data information.

AIoT Xingtu Research Institute is based on the professional accumulation of Ulinkmedia and IOTE Internet of Things Exhibition for nearly 20 years, 8000+ customers and 20W+ user resources, combining professional experience with down-to-earth industry research, bringing the most reliable information intelligence, the most comprehensive research, the most real trends, the most authoritative interpretation, and the most professional insights to the AIoT industry.

Contact Us

Business cooperation

Industry analyst

IOTE·中国RFID无源物联网产业图谱（2024版）

发布单位：AIoT商图研究院 | 物联传媒 Ulink Media | 深圳市物联网产业协会 SZIOT
参编单位：Checkpoint | DASCOM | Kiloway | Sense Technology 先拖科技 | ZSF | Pragmatic
赞助单位：国芯物联 NATION RFID | 远望谷 | 深圳市瑞福智能芯片有限公司 | SILION 可联 | 中科长川微芯 INFINITECH

UHF产业篇

·标签芯片·
复旦微 | 坤锐电子 | 凯路威 | NXP&威健
国芯 | 平头哥 | 星沙科技 | EM·时尚科技
Pragmatic | 宣链 | 英频杰 | 意联

·标签天线·
科睿坦 | 文森斯诺 | 圆准股份
美思特 | 科宇金鹏 | 启东英内
英内尔 | 微感电子 | 哈深特材
华信天线

·读写器芯片·
国芯 | 复旦微
旗连 | PHYCHIPS
御芯微 | 英频杰

·读写器天线·
博纬智能 | 启瑞天
安的 | 瑞弗艾迪
迈纵 | 桥恩
华贸 | 澳信
东振技术 | 舜识物联网
微感电子 | 康荣高科

·标签厂商·
保点 | 中世发 | 远望谷 | 鹏思物联
信达物联 | 文森斯诺 | 飞利华 | 英诺尔
博纬智能 | 康坦 | 腾彩科技 | 艾利
硕电 | 永道 | 芬欧蓝泰 | 锐驰
植富 | 立芯 | 安智博 | 圆准股份
建和智能卡 | 产业智能 | SML集团 | 美思特
铭琪 | 伊泰特伦 | 融智兴 | 卡的智能
德聚 | 迈德物联 | HID | 耀福
英内 | 恩福芯 | 沸脑智能 | 澳普
劲行 | 良皓 | 美声 | 永圣高
奇志 | 富卡思通 | 必应标签 | 杰睿智能
文标 | 泰芯 | 毕昇 | 硕道物联
联合智能 | 瑞诚智能 | 福智物联 | 顺驰智能
日晖智能 | 芯诚智能 | 南京中卡 | 芯阅物联
奥立宏 | 赞润微电子 | 鼎券物联 | 上海中卡
意联 | BEONTAG | 鑫卡立方 | 运桥智能卡
新歌山 | 尼太普 | 芯诚智领 | 够乐
科迈瑞 | xerafy | 联恒物宇 | 天德
拓扑泰革 | 琛卡物联 | 华海智能卡 | 春笙物联
品冠 | 顺驰智能 | 金海星 | 微感电子
星必达 | 华森通 | 亿卡智能 | 南京川琪
Hana | 优浩塑胶 | 一芷科技 | 嘉创电子
开心物联 | 康荣高科 | 智芯微 | 先讯美资
德健智能 | 勤业物联 | 旭澜卡

·标签材料·
3M | 芬欧蓝泰 | 爱卡智能 | 昌泓塑业
四发实业 | 宏盾防伪 | 卡迪影像 | 科田智能卡
金中楷 | 冠美科技 | 乐乐影像 | PPI
运研材料 | 星必达 | 华彩科技 | 哈深特材
星必达 | 摩尔佳 | 芯诚智能 | 金鑫新材料
骏悦塑料五金 | 金盾兴 | 康荣高科 | 圆芯电子
鹏瑞新材料 | 鑫卡立方 | 铭奋电子 | 吉瑞鑫
德健智能 | 广州欣竹

·封装设备·
新晶路 | 中科长光精拓 | 源明杰
纽约 | 久元 | 安泰可
巽文智能

·复合设备·
新晶路 | 源明杰 | 森卡精工
百威勒必诺 | 永盛 | 纽约
传麒智能 | 驰立 | 武汉文林
永盛嘉 | 哈德胜 | 维聚
爱博智控

·检测设备、喷码/写码设备、裱卡机·
新晶路 | 中科国技 | 微嵌标识
Voyantic | 源明杰 | 唐领
联点 | 制联 | 驰立
永盛嘉 | 巨心物联 | 旭弘
巽文智能 | 简仪

·RFID打印机·
得实集团 | 博思得 | 雷丹
成为 | 霍尼尔 | 佐藤
斑马技术 | TSC Auto ID | 东芝泰格
爱印科技 | 德佟 | 品胜科技
致明兴 | 宝比万像 | 杰睿智能

·固定式读写器/设备·
先施科技 | 芯联创展
捷通 | 万全智能
博纬智能 | 国芯
远望谷 | 斯科
华士精成 | 成为
永道 | 蓄яр科技
立芯 | 辰芯智能
五兆合 | 煜微智能
鸿陆 | HID
安的 | 英内
东淑 | 金瑞铭
杰睿智能 | 物必连
威海北洋 | 荣睿
创方科技 | 孚恩
瑞杰物联 | 罗维尔
迅捷无线 | 华贸
普润 | ELYCTIS
骏发瑞达 | 卓羽信息
金中天 | 英频杰
奥贝德 | 诺万特
知行物联 | 上海科浩
迪川电子 | 舜识物联网
锦鸿源创 | 龙杰科技
创自技术 | 智芯微
思谷

·手持机/工业平板·
芯联创展 | 远望谷
北斗星通 | 金泰谊
成为 | 盈达
亿道信息 | 蓝畅科技
东集 | 霍尼韦尔
斑马技术 | 思必拓
鸟鸟科技 | 群索科技
煜微智能 | 祥瑞通讯
鸿陆 | 赫盛光电
海雅达 | HID
安的 | 英内
凡维信息 | 炅梦智能
汉德霍尔 | 睿思科
唯畅信息 | 天龙世纪
积赞 | 创方科技
联芯物联 | 明日星
孚恩 | 迅捷无线
信联智能 | 意联
芯固 | 道格
友恺通信 | 唯畅信息
万全智能 | 精瑞电脑
优尚丰 | 荣睿
世美智能 | 优领通
上海科浩 | 微嵌计算机
舜识物联网 | 硕腾科技
东极星 | 迅镭智能
万酷电子 | 英诺尔

·行业应用·
鞋服与商超零售 | 图书馆 | 仓储物流 | 快递包裹 | 食品&药品 | 医疗 | 珠宝 | 洗涤 | 仓储 | 资产管理 | 航空行李 | 电子车牌 | 工业制造 | 电力 | ...

HF产业篇

·标签/卡类芯片·
凯路威 | 复旦微 | 聚辰半导体
意法半导体 | NXP&威健 | 坤锐电子
每开创新 | EM·时尚科技 | 飞聚
华翼微 | 稻源 | Pragmatic

·读写器芯片·
华翼微 | 复旦微 | 意法半导体 | 飞聚
中科微 | 动能世纪

·标签/卡类厂商·
鹏思物联 | 信达物联 | 远望谷
英诺尔 | 金强人 | 腾彩科技
艾利 | 优比科 | 永道
锐驰 | 安智博 | 圆准股份
建和智能卡 | 产业智能 | 美思特
赛尔瑞 | 铭琪 | 康伴医疗
爱卡智能 | 融智兴 | 卡的智能
德聚 | 迈德物联 | HID
英内 | 沸脑智能 | 澳普
良皓 | 双景 | 美声
永圣高 | 奇志 | 意诚信通
富卡思通 | 必应标签 | 文标
贝迪 | 永芯达 | 毕昇
硕道物联 | 思昊智能 | 唯畅信息
联合智能 | 蓝迅电子 | 瑞福智能
顺驰物联 | 日晖智能 | 芯诚智能
文森斯诺 | 南京中卡 | 芯阅物联
赞润微电子 | 鼎券物联 | 上海中卡
意联 | BEONTAG | 鑫卡立方
运桥智能卡 | 新歌山 | 点晨科技
科迈瑞 | 联恒物宇 | 够乐
拓扑泰革 | 琛卡物联 | 顺驰智能
春笙物联 | 华海智能卡 | 硕电
金海星 | 微感电子 | 星必达
亿卡智能 | 南京川琪 | Hana
优浩塑胶 | 一芷科技 | 嘉创电子
开心物联 | 康荣高科 | 智芯微
华森通 | 德健智能 | 勤业物联
旭澜卡

·手持机/工业平板·
远望谷 | 英诺尔
北斗星通 | 金泰谊
成为 | 盈达
亿道信息 | 蓝畅科技
东集 | 霍尼韦尔
斑马技术 | 思必拓
鸟鸟科技 | 群索科技
煜微智能 | 祥瑞通讯
鸿陆 | 赫盛光电
民理电子 | HID
安的 | 英内
精瑞电脑 | 意诚信通
贝迪 | 凡维信息
炅梦智能 | 汉德霍尔
睿思科 | 唯畅信息
天龙世纪 | 积赞
创方科技 | 联芯物联
明日星 | 孚恩
迅捷无线 | 信联智能
意联 | 芯固
道格 | 友恺通信
唯畅信息 | 万全智能
优尚丰 | 荣睿
世美智能 | 优领通
上海科浩 | 微嵌计算机
舜识物联网 | 硕腾科技
东极星 | 迅镭智能
万酷电子

·固定式读写器/设备·
万全智能 | 捷通
思谷 | 博纬智能
远望谷 | 斯科
成为 | 辰芯智能
ELYCTIS | 五兆合
煜微智能 | 鸿陆
HID | 安的
英内 | 双景
神州盾 | 华翼微
物必连 | 威海北洋
荣睿 | 创方科技
华闰得 | 孚恩
迅捷无线 | 普润
鼎券物联 | 骏发瑞达
卓羽信息 | 易火眼
创自 | 金瑞铭
奥贝德 | 诺万特
知行物联 | 上海科浩
迪川电子 | 舜识物联网
锦鸿源创 | 龙杰科技
北京智芯微 | 罗维尼

·行业应用·
防伪溯源 | 图书馆 | 门禁 | 金融 | 交通 | 医疗 | 校园 | 工业 | ...

LF产业篇

·标签/卡类芯片·
坤锐电子 | EM·时尚科技 | 卓捷创芯
SIC | 华森通 | 瑞新

·读写器芯片·
EM·时尚科技 | 中科微
动能世纪 | NXP

·标签/卡类厂商·
HID | 驭景 | 文标
瑞福智能 | 日晖智能 | 千精思
芯诚智领 | 优浩塑胶 | 硕电

·读写器·
捷通 | 万全智能 | HID
驭景 | 霍尼韦尔 | 易火眼
荣睿

·行业应用·
宠物 | 家畜 | 禽类 | 门禁 | 汽车防盗 | 地理 | ...

CONTENTS

Chart catalog

Preface

There are many theories about the origin of the Internet of Things industry. In China, many people regard 2015-2016 as the first year of China's IoT industry. The landmark event was the rise of LPWAN technology represented by NB-IoT.

Because before that, although there were many IoT companies in the market making IoT products, they mainly reused technologies from the original industrial chain such as mobile phones, PCs, automobiles, and industry.

NB-IoT is a new technology specifically created to meet the low-cost, low-power, and large-connection requirements of IoT scenarios. It has been supported by national policies and endorsed by industry chain players. So, from this perspective, it makes sense that the rise of NB-IoT has boosted the entire IoT industry.

But the problem is that NB-IoT has been around for nearly 10 years, but it is clear that it is not the real answer to the Internet of Everything. According to the information we have obtained from the market, the annual terminal shipments of the NB-IoT market in China and even the world do not exceed 100 million, and are still facing a downward trend.

So what kind of technology is the real answer to the Internet of Everything? In order to analyze this problem, we need to introduce a pyramid model.

The first one is the pyramid model commonly used in the industry when NB-IoT first emerged (mainly for cellular IoT connections), as shown below:

Cellular IoT Pyramid Model

- Video surveillance
- Telemedicine
- Autonomous driving

10% High speed business — LTE Cat.4、LTE Cat.6、5G...

- Wearable devices
- Elevator monitoring
- POS machine
- Logistics

30% Medium and low speed services — LTE Cat.1、eMTC

- Meter reading
- Street lights
- Environmental management
- Municipal Management
- Smart Parking

60% Narrowband services — NB-IoT
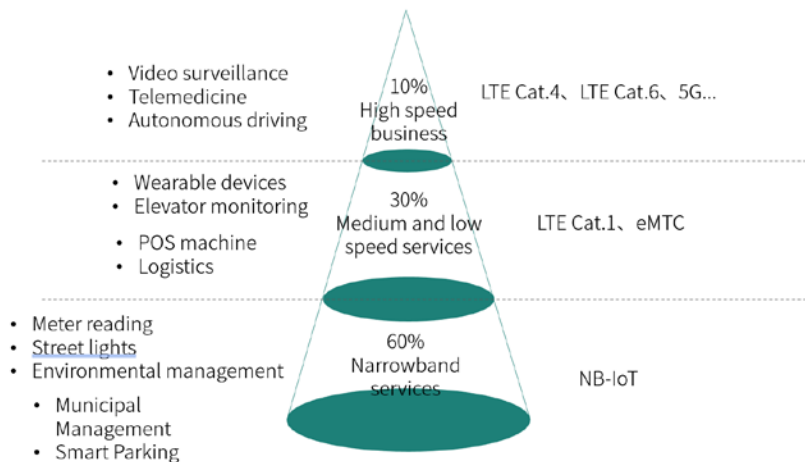
Cartography: AIoT Xingtu Research Institute

The contents of different versions of the pyramid model are slightly different, but the basic logic is: among the connected devices of the Internet of Everything, the cheapest devices account for the largest proportion, and to connect such low-value devices to the Internet, low-cost, low-power connection technology is needed, and the characteristics of NB-IOT are very suitable for this.

However, after years of development, NB-IoT's application scenarios have gradually been limited to a small number of scenarios such as meter reading, and have not met expectations. And because Cat.1 technology is mature, combined with the background of 2G network withdrawal, the popularity of this technology is very fast, and it has become the largest technology type in cellular Internet of Things technology.

Because Cat.1 is a representative technology of medium speed, an "egg" model has appeared in the market.

Cellular IoT Egg Model
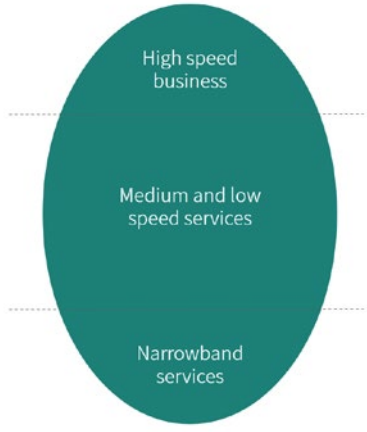
Cartography: AIoT Xingtu Research Institute

Is the "pyramid" model really invalid? In fact, it is not. Instead, the low-speed and low-cost technical solution will be undertaken by other technologies, and the answer is the passive Internet of Things.

IoT connectivity pyramid model
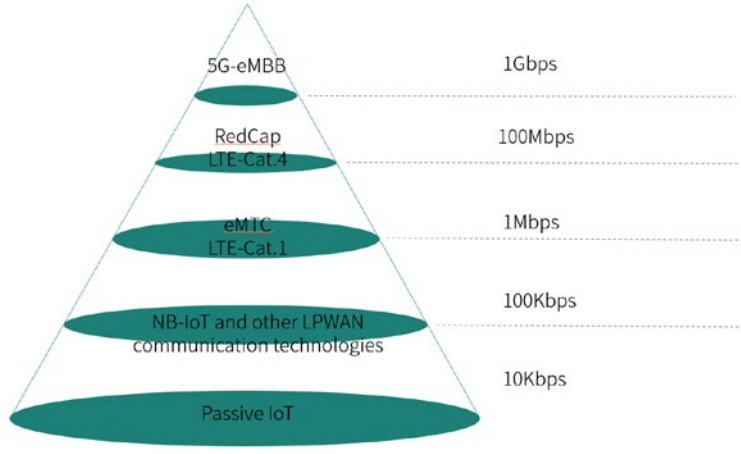
Cartography: AIoT Xingtu Research Institute

Why is passive IoT the answer to the times?

We can answer this question with a simple elimination method.

The main cellular communication technologies on the market are: NB-IoT, 4G-Cat.1, 4G-Cat.4, 5G, and 5G-Redcap.

From a cost perspective, the cheapest are NB-IoT and Cat.1. The module cost of the two is about 10 yuan. In addition, because it is an active technology, it needs to be powered by batteries. Some scenarios require large-capacity batteries, and the battery cost is sometimes higher than the module cost.

How many common items in people's daily production and life can afford to increase the connection cost by dozens of yuan? The answer is obvious. Even the cheapest NB-IoT and Cat.1 are still far from the goal of "Internet of Everything".

And all kinds of daily necessities around us, materials and products in industrial production, etc., all have management needs, but if the cost is too much, they will not be accepted by the market.

Therefore, the main cellular passive IoT products with extreme low cost will be the answer to the times. This is not just a pie in the sky, but a direction determined by the industry.

The concept of cellular passive Internet of Things has been proposed in the Rel-18 version of 3GPP. It is expected that the relevant standards will be officially frozen in the Rel-19 version to be released in 2025. At present, the leading companies in the industry are actively making early arrangements.

After the standard is officially released, the passive Internet of Things will be incorporated into the cellular communication industry, which will release huge market potential and is also a big boon to the RFID passive IoT industry. This is because the cellular passive IoT industry will reuse most of the current RFID passive IoT industry chain resources, including the production of RFID Labels, RFID readers, and the design and implementation of solutions, and all other links will benefit.

Last year, we released the "2023 China RFID Passive Internet of Things Industry White Paper and 10 Segment Market Research Report". The readers of this white paper not only cover people in the RFID circle, but also let people in the entire Internet of Things circle understand the extremely cost-effective technology of RFID passive Internet of Things.

From the perspective of dissemination, the online conference of this white paper attracted more than 5,000 viewers, and according to our backend statistics, the number of downloads of the white paper exceeded 20,000 (secondary dissemination cannot be traced), and the number of views exceeded 200,000. In addition, 4,000 paper copies were distributed through the IOTE Internet of Things Exhibition and offline activities.

The wide dissemination has also made this white paper receive good feedback from all walks of life, which also allows us to see the value and significance of this white paper. Therefore, AIoT Star Map Research Institute will continue to update this white paper in 2024.

In the new version of the white paper in 2024, we will determine the format of this ecological report as: "1 white paper" + "7 segmented application market research reports" series of reports.

Specifically:

1 White Paper:

"2024 China RFID Passive Internet of Things Industry White Paper"

7 vertical application market research reports:

"China RFID Passive Internet of Things Ecosystem Report: Footwear andClothing and Supermarket Retail Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report: Express Logistics Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report–Aviation Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report – Book and Archive Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report Industrial Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report Medical Application Market Analysis Report (2024 Edition)"

"China RFID Passive Internet of Things Ecosystem Report: Urban Public Utilities Management Application Market Analysis Report (2024 Edition)"

Part 1

Introduction to RFID Passive Internet of Thing

1.1 What is Passive IoT?

Passive IoT, as the name suggests, involves IoT devices that do not rely on a dedicated power source (without batteries or wired connections). Instead,these devices operate by harnessing minute amounts of energy from their surrounding environment to function seamlessly.

It is often said, "Water is the source of life," and similarly, energy serves as the lifeblood for driving IoT devices. Throughout the annals of human history, energy has held a paramount position in our development. Presently, our mastery of energy harvesting, storage,and utilization has reached a remarkable level, to the extent that many tend to overlook its omnipresence. However, within the IoT industry, the significance ofenergy is increasingly pronounced.

In recent years, emerging transmission technologies such as NB-IoT and LoRa have touted one of their primary selling points as low power consumption. Meanwhile, in the realm of mature wireless transmission technologies like Bluetooth, Wifi, and Zigbee, one of the key focal points in the evolution of eachsuccessive generation is how to achieve even lower power consumption.

Why the IoT market places so much emphasis on low power consumption?

In the IoT market, 20 billion, 50 billion, and 100 billion connection figures frequently appear in people's vision.

If these huge IoT devices are all powered by batteries, considering both explicit and implicit costs, the cost proportion of batteries in IoT devices cannot be underestimated.

- Explicit costs encompass the purchase cost of batteries and labor expenses. At first glance, batteries may seem inexpensive, but even the most cost-effective unit price, when multiplied by 500 billion, becomes a substantial figure. Furthermore, if the power consumption is high, the cost of replacing batteries for a single device becomes even higher.

- Implicit costs pertain to the changes in the physical dimensions and environmental impact brought about by batteries in IoT products. Although implicit costs cannot be precisely quantified, their overall impact is considerable.

Many scenarios necessitate synchronizing the lifespan of a single battery with the iteration cycle of IoT devices. In other words, when the battery is depleted, the device also requires replacement.

This demand has spurred various IoT-related technologies to evolve towards lower power consumption. This not only includes wireless communication technologies but also low-power sensor products, low-power IC architectures, even lower-power basic materials, and more energy-efficient software systems, all of which are gradually gaining prominence.

However, in active devices, no matter how low the power consumption is, batteries are still needed. So, can IoT devices completely get rid of the limitations of batteries and function normally without batteries? The answer is yes. This is the proLabelonist of this white paper - passive IoT technology.

Passive IoT technologies are mainly divided into the following categories:

The first method involves harnessing ambient radiofrequency energy from the surrounding environment. For instance, 4G signals, 5G signals, Wi-Fi signals, Bluetooth signals, and the like all represent sources of energy transfer.

This is also the most popular method, because for an IoT device to operate normally, in addition to obtaining working energy, it also needs to transmit data information, and the transmission of signals also relies on radio signals. Therefore, the use of radio can not only obtain energy but also transmit signals, making the system very simple, while also saving costs and reducing size.

The second common method revolves around solar energy harvesting. Solar power can provide substantial electrical energy, but it entails complex systems and higher costs. Although it finds application in certain scenarios, it is evidently unsuitable for large-scale, cost-effective IoT applications.

The third method entails piezoelectric generation, wherein mechanical force induces a change in material shape, generating electrical current. This approach has its own set of suitable use cases, such as switches and remote controls. However, this hands-on approach is evidently ill-suited for the majority of scenarios.

Furthermore, in addition to these methods, there are also solutions in the market that harness environmental energy sources like temperature differentials and vibrations.

1 Comparison of several major environmental energy harvesting technologies

Technology	AdvanLabeles	DisadvanLabeles	Application scenarios
Radiofrequency (RF)Waves	• Ubiquity of electronic devices;infrastructure can be repurposed • Small size, easy deployment • Low cost	• Lower energy density; requires a separate energy source	Clothing retail,Libraries,Parcel tracking in logistics,Jewelry tracking,Asset management, Anti-counterfeiting and traceability,among others
Solar Energy	• Temperature Differential • Relatively easy to acquire • Mature industry supply chain	• High cost • Large size • High installation and maintenance costs	Street lighting, Outdoor monitoring, Agriculture, Industrial settings,among others
Piezoelectric(Pressure-based)	• Convenient energy acquisition • Low cost	• Lower energy density • Smaller industry supply chain	Switches, Remote controls
Temperature Differential	• Wide range of applicable energy environments	• Wide range of applicable energy environments (in some cases)	Forest fire prevention, Outdoor environmental monitoring

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

The passive IoT approach using radiofrequency signals is indeed the most widely applied method, and it represents a key focus of this report's research efforts.

Passive IoT is not a new technology, so why has it received so much attention recently?

The first reason: Sustainable development, energy conservation and environmental protection are common global themes of the times.

In the current global context, the protection of the natural environment to promote sustainable human development has become a paramount concern.

China, in particular, has introduced the concepts of "carbon peak" and "carbon neutrality."

In some specific industries, there are clear environmental protection requirements, or products with environmental protection concepts will be given priority, which will directly drive the application of products with environmental protection concepts. Batteries are very harmful to the environment, so in the context of the times, passive Internet of Things technology that absorbs radio wave energy in the environment has received special attention.

The second reason: The application demand side requires reducing the cost and size of IoT devices.

If IoT devices are freed from the constraints of batteries, they can be smaller in size and more flexible in form, or even in the form of flexible patches for easier application.

Moreover, eliminating the need for batteries can significantly reduce costs, which is especially critical for many low-cost products. Even small cost differentials, on the order of a few cents, can have a substantial impact on the viability of a wide range of application scenarios.

The vision of the Internet of Things is indeed "connecting everything," but for many low-priced products such as bottled water, snacks, and courier packages, where unit prices and profit margins are minimal, employing battery-powered connectivity is clearly not suitable. Hence, adopting low-cost passive connectivity solutions becomes the inevitable choice to unlock connectivity at the scale of billions, or even trillions, in such scenarios.

Why will RFID become the answer of the times?

There are many wireless transmission technologies. Why is RFID the answer of the times?

There are two main indicators to judge the pros and cons of a passive technology. The first indicator is the working distance. The longer the working distance, the wider the applicable scenarios. The second indicator is cost. The biggest selling point of the passive Internet of Things is low cost. Whoever has a lower cost will have more advantages.

1. Compared with other wireless technologies, passive RFID can transmit farther

In order to achieve a longer transmission distance, the radio wave passive IoT solution has two requirements for the product.

Firstly, the efficiency of absorbing energy from radio waves must be high.

The extraction of energy from radio waves can be categorized into near-field and far-field transmission. Near-field energy transmission primarily

relies on the inductive coupling of coils and is characterized by short transmission distances. For instance, NFC (Near Field Communication) employs this method, typically operating at distances of just a few centimeters.

Far-field transmission is a microwave radiation system, and the transmission of electromagnetic energy is completed in the far-field area (radiation field). Common communication technologies such as UHF RFID, Bluetooth, Wi-Fi, etc. all complete energy transmission in the far field.

The conditions that primarily influence far-field energy transmission can be summarized into three key factors: signal source transmission power, antenna size, and the frequency of radio waves.

Transmission power is subject to strict regulations in each country, especially for consumer products, which impose upper limits on transmission power to avoid interference with other signals or potential radiation hazards to humans. Apart from the fact that the operator's cellular communication technology has a higher transmission power than the unlicensed spectrum, other technologies are not much different. The antennas of each technology are universal and do not make any difference.

Therefore, the biggest factor affecting radio wave energy transmission is the frequency of the electromagnetic waves. Which frequency band has higher energy transmission efficiency?

Below is a set of test data: Fixed transmission antenna output power and receiver antenna size were kept constant, and readings were recorded for different frequencies to determine the working distance, as depicted in the following graph illustrating the working distances at different frequencies.

Working distance diagram at different frequencies

From this, it can be seen that the frequency band with the highest energy efficiency of far-field transmission is in the range of 800MHz–1GHz, and UHF RFID happens to work in this frequency band.
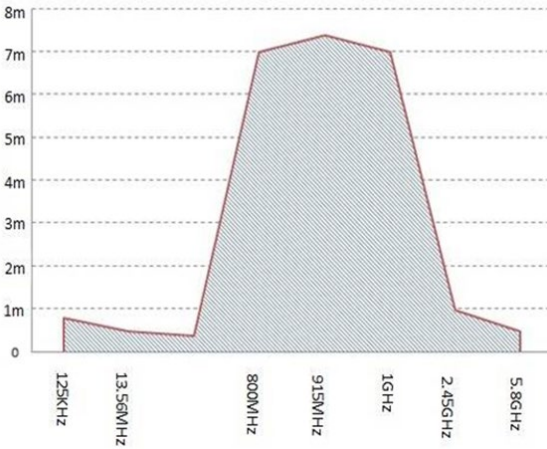
Source: "IoT UHF RFID Technology, Products and Applications", author, Ganquan

Several main wireless technology operating frequency bands:

Wireless technology	UWB	Bluetooth	Wi-Fi	UHF RFID
Working frequency	3.1 GHz- 10.6 GHz	2.4GHz	2.4GHz /5GHz /6GHz	860-960MHz

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Second, the working current of the chip must be low enough

The lower the working current of the chip, the farther the corresponding working distance will be. We have calculated the working current of several types of communication technologies with similar frequencies, as shown in the figure below:

Technology	UWB	Bluetooth	Wi-Fi	UHF RFID
Working current	30-60mA(there is also low-power UWB technology on the market that can reduce power consumption to less than 10mA)	Generally between 5-20mA,the lowest operating current on the market can be below 2-3mA.	Generally above 100mA	The minimum operating current is only a few µA,and generally requires dozens of µA during normal operation.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Through the delineation of these two dimensions, a lucid conclusion emerges: RFID stands as the paramount passive Internet of Things (IoT) technology.

2. RFID has obvious cost advanLabeles

Presently, RFID Label usage has surged into the billions annually, with its colossal scale serving as a catalyst for steadily declining Label costs. As domestic chip and equipment production gains momentum alongside advancements in manufacturing processes, we can anticipate further optimization of Label costs.

In contrast, alternative passive IoT technologies such as Wi-Fi, Bluetooth, and UWB entail chip costs ranging from several dollars to tens of dollars per unit. Even when simplifying functionalities and cost optimization are pursued to align with passive scenarios, these alternatives face considerable difficulty in matching RFID's cost-efficiency.

Hence, from the perspective of cost, RFID emerges as the correct solution for future low-cost IoT connectivity on the order of hundreds of billions.

Absolutely, RFID technology is not a universal technology, which also has certain limitations. Firstly, its capabilities are rather straightforward, primarily suited for storing and transmitting small data quantities. If the application scenario demands more complex data handling, RFID may not be the most suitable choice. Secondly, UHF RFID lacks the ability to interact with smartphones, necessitating the addition of dual-mode solutions like NFC, which can increase costs and have limited transmission distances.

1.2 What is RFID Passive Internet of Things

1.2.1 Overview of RFID technology

RFID, which stands for Radio Frequency Identification technology, is a non-contact automatic identification technique. It facilitates bidirectional data communication through wireless radio frequency methods, allowing for the reading and writing of electronic Labels or radio frequency cards. This process enables data communication between the reader and the Label, thereby achieving the goal of identifying targets and exchanging data.

1 Basic principles of RFID

The fundamental components of an RFID system include RFID electronic Labels, readers/writers, and application software. It constitutes an automatic identification system that utilizes radio frequency identification technology for data collection and transmission.

In typical scenarios, RFID electronic Labels enter the electromagnetic field emitted by the reader/writer. They derive induction current from the antenna, which is then transformed into power for the chip through a boosting circuit. Simultaneously, the energy obtained from the induction current is converted into a digital signal through the radio frequency frontend circuit and sent to the logic control circuit for processing. Information that requires a response is transmitted from the Label's memory, and it is sent back to the radio frequency frontend circuit through the logic control circuit. Finally, it is transmitted back to the reader/writer through the antenna.

1. RFID label

RFID electronic labels are data carriers used for item identification, have information storage mechanisms, can receive electromagnetic field modulation signals from readers and writers, and return response signals. They are usually called electronic labels. Together with readers and writers, they constitute the hardware body of the RFID system. The core components of RFID electronic labels are label antennas and label chips. From the manufacturing process point of view, the entire process of RFID electronic labels includes chip supply, antenna manufacturing, primary packaging (forming Inlay), secondary packaging (compounding), and post-printing.

Introduction to electronic label packaging technology

Presently, RFID electronic Label encapsulation technology primarily comprises two processes: Flip Chip technology and COB (Chip-on-Board) technology. The key workflows for these two processes are illustrated in the diagram below:
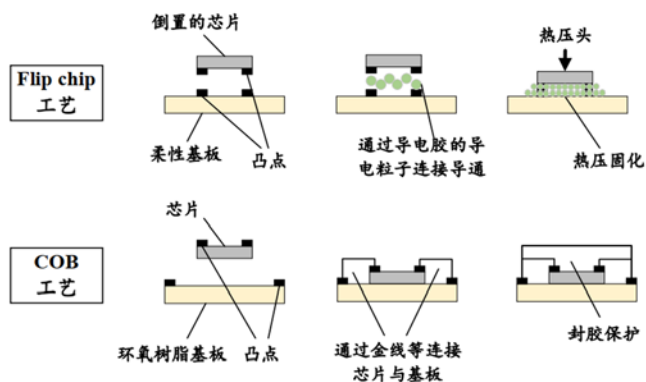
● **Working distance diagram at different frequencies**

The flip chip process employs fully automated production equipment known as the bonder, which takes advanLabele of the conductive adhesive's electrical and thermosetting properties. It uniformly dispenses the conductive adhesive between the chip and the substrate, and through a process of thermal compression, cures the conductive adhesive, thereby establishing electrical connectivity between the chip and the substrate. The flip chip process is distinguished by its high efficiency and cost-effectiveness, making it well-suited for accommodating flexible substrate materials and enabling mass production.

In contrast to the flip chip process, the COB (Chip-on-Board) process involves a more intricate production sequence. It employs wire bonding to connect the chip to the substrate and protects the wires through a process of encapsulation. COB processes typically use rigid materials like epoxy resin as substrates, and the encapsulation safeguards the wires. As a result, RFID electronic Labels produced via the COB process tend to have a relatively longer lifespan. In scenarios where there are special requirements for application environments and product longevity, such as in the production of identification cards, bank cards, and similar items, the COB process remains the preferred choice.

Process name	Technical path	Production equipment	Production cost	Service life	Main application areas
Flip chip	Directly connect the chip to the substrate through conductive glue	RFID die bonding machine (binding machine)	Lower	Shorter	Wide range of applications, including clothing Labels,airline luggage Labels,book Labels,etc.
COB	Use metal wire to connect the chip to the substrate,and protect the gold wire by sealing	Wire bonding machine	Higher	Longer	Identity cards,bank cards and other areas that need to be reused multiple times

Cartography: AIoT Xingtu Research Institute

Certainly, the disparities between the Flip Chip process and the COB (Chip-on-Board) process are outlined in the table below:

In recent years, the ever-maturing Flip Chip process has significantly enhanced the production efficiency of RFID electronic Labels, while simultaneously reducing production costs and broadening the scope of application. In industries with the most widespread application, such as the fashion and footwear sector, Ultra High Frequency (UHF) RFID electronic Labels are predominantly manufactured using the Flip Chip process.

RFID Label classification

According to the power supply method, RFID Labels can be divided into Active Labels, Passive Labels and Semi Active Labels.

	Passive labels	Active labels	Semi-Active labels
working principle	The reader\writer reads the radio electromagnetic waves emitted by the antenna and then generates signal transmission inside the Label.	Powered by an external power supply and actively sending signals to the reader	Normally,semi-active RFID Labels are in a dormant state. When the Label enters the recognition range of the reader,it will be activated and enter the working state.
Main working frequency band	Lowerfrequency band in125-135KHz,13.56MHz, 860-960MHz	Higher frequency band in 433 MHz,2.4GHz,5.8GHz	The reader first uses a 125KHz low-frequency signal to accurately activate the Label within a small range to enter the working state,and then transmits information to it through 2.4GHz microwave
Features	Because the power supply system is omitted,the Label size can be on the order of centimeters or even smaller,with low cost,low failure rate,and long service life,but the effective recognition distance is relatively short.	The transmission distance is longer,generally up to 120-150 meters;the transmission speed is high Multi-Label reading is faster but more expensive	Multiple readers need to be placed at different locations to activate semi-active RFID Labels.They are mostly used in situations where there are both positioning requirements and information collection and transmission requirements with wide coverage of frequency signals.
Typical application	Shoes and clothing retail,books and archives, express logistics,industry,etc.	Highway electronic non-stop toll collection System	/

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

In this white paper, we focus on analyzing the relevant content of passive RFID. According to the frequency, RFID Labels can be divided into low-frequency Labels, high-frequency Labels, ultra-high-frequency Labels and microwave Labels. Microwave is an active form and is not within the scope of this white paper.

2.RFID reader-writer

RFID reader-writer can read and write electronic Label information.

RFID readers and writers can be categorized into different product types based on their operating frequencies, which include Low Frequency (LF), High Frequency (HF), Ultra High Frequency (UHF), Microwave, and others. They are used in conjunction with RFID Labels that correspond to their respective frequency bands.

In terms of the integration of the reader module and antenna, RFID readers can be classified as Integrated Readers (where the reader module and antenna are enclosed in a single unit) and Split Readers (where the reader module and antenna are physically separated and connected using coaxial cables).

Currently, the most commonly used reader-writer classification on the market is divided into fixed reader-writer and handheld reader-writer according to portability. Fixed reader-writers include gateway reader-writers, card issuing machines, cabinets, etc.; handheld readers include handheld devices, wearable readers, etc.

2.RFID technology advanLabeles

In addition to RFID, currently commonly used data identification technologies on the market include ETC, barcodes, and QR codes. The following table provides a detailed comparison of these technologies:

	UHF RFID	ETC	Bar code	QR code
concept	Radio frequency identification can be divided into low frequency,high frequency,ultra high frequency and microwave according to different frequency bands.	Non-stop electronic toll collection system (Electronic Toll Collection)	A barcode is a graphical identifier that expresses a set of information by arranging multiple black bars and blanks of varying widths according to certain encoding rules. A common barcode is a parallel line pattern composed of black bars(referred to as bars) and white bars(referred to as spaces) with very different reflectivities	QR code is also called 2D barcode. Common QR codes are QRCode and GM code.It is a very popular encoding method on mobile devices in recent years.A OR code is a multi-line,continuoUS, variable-length symbol that contains a large amount of data.
Application scenarios	Warehousing and logistics, book lending and return, file management,personnel management,asset management, commodity inventory,electronic fence,animal management,etc	Highway toll stations and parking lot tolls	Commodities,traceability,etc.	Commodity,electronic payment, traceability,etc.
information carrier	RFID Label,alsocalled electronic Label	ETC electronic label	Traditionally,paper carriers are Used,but there are also plastic,cloth,etc	Paper or electronic QR code
Grouped equipment	Labels,antennas,readers,application software	ETC electronic Labels,automatic vehicle identification systems, central management systems and other auxiliary facilities	Barcode labels,barcode generation equipment,barcode readers and computers	QR code,reader-writher
Storage	The maximum capacity can reach several MB	/	50Bytes	2000 to 3000 characters
Usage requirements/ feature	①Not restricted by environment, can read multiple times and blindly②Strong penetrability ③Strong anti-interference ability	Anair transaction in the ETC system takes about 200ms,so the collection can only be completed when the vehicle speed is lower than 60km/h.	①It is required to have a certain clarity and avoid breakage and stains.②The area is too small and sometimes difficult to identify	Can be used on smaller spaces, but there are still requirements for its print size
Operating mode	Contactless two-way data communication via radio frequency	ETC electronic Labels carry out dedicated short-range communication with the microwave antenna in the ETC lane	One-to-one close range unobstructed scanning	One-to-one close range unobstructed scanning
Security Level	Information is stored in the chip and the data content is password- protected and cannot be easily forged,stolen,or altered.	The system security encryption algorithm is DES algorithm,not a standard commercial secret algorithm with purely national independent intellectualproperty rights.	Not encryptable	/
Information characteristics	The information of the chip can be rewritten repeatedly and has a long service life.	ETC cannot identify vehicles and can only be used to collect fees	Information cannot be changed after printing	/

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

1.2.2 RFID standard system

With the blossoming of the RFID industry worldwide, the goal of establishing a standardized framework for RFID technology has gained global attention. This aim is to ensure the mutual compatibility of products produced by different companies, promote the widespread use of RFID technology, optimize its functionality, reduce trade barriers for RFID products across nations, and realize the freedom of trade in the RFID industry. At present, RFID has gained recognition through international standardization systems like GS1, ISO/IEC, and others. However, the standardization of IoT in China is still in its nascent sLabeles, with only a handful of foundational standards in existence.

As of today, six prominent organizations globally have succeeded in establishing influential RFID standardization frameworks, namely ISO/IEC, EPCglobal, UID, AIM, IP-X, NFCForum, and RAIN RFID. These organizations play a pivotal role in shaping the direction and standardization of the RFID industry on a worldwide scale.

1 Global RFID Standardization Organizatio

1.ISO/IEC

ISO stands for the International Organization for Standardization, while IEC stands for the International Electrotechnical Commission. Both are globally recognized nonprofit organizations dedicated to standardization. Standards jointly published by these two entities are referred to as ISO/IEC standards. In comparison to other organizations, ISO/IEC enjoys an exceptional level of authority and credibility. Within this organization, multiple technical committees are established, each specializing in RFID standardization research. They have released standards for various RFID frequency bands.

Most of the current international RFID standards are jointly issued by ISO and IEC, so they are called ISO/IEC standards.

🔴 **Overview of RFID standards developed by ISO/IEC**

ISO/IEC Technical Standard
- ISO/IEC 18000 "Air interface parameters"
- ISO/IEC 10536 "Close coupled integrated circuit card"
- ISO/IEC 15693 "Sparse coupled integrated circuit card"
- ISO/IEC 14443 "Near coupled integrated circuit card"

A Technical Standards	B Data structure standards
ISO/IEC10536 / ISO/IEC14443	ISO/IEC15424 / ISO/IEC15418

C Performance Standards	D Application Standards
ISO/IEC18046 / ISO/IEC18047	ISO/IEC10374 / ISO/IEC18185

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.EPC global

EPCglobal was established under the auspices of the Global Standards 1 (GS1), which was formerly known as the European Article Numbering International (EAN International). EAN International had its origins in the European Article Numbering Association, established in 1977. In 1981, it transformed into the International Article Numbering Association, and in 2002, it formally welcomed the participation of the Uniform Code Council (UCC) from the United States and the Electronic Commerce Council of Canada (ECCC). In 2005, EAN International, underwent a name change, becoming GS1. GS1 is globally renowned as the leading international organization responsible for the research and promotion of barcode technology. Its mission revolves around advancing the universal language of business, known as the EAN.UCC system, which, in China, is referred to as the ANCC Global Trade Identification System, or ANCC system for short.

3.UID

The Ubiquitous ID Center, commonly referred to as UID, was established in March 2003 as a subsidiary of the T-Engine Forum in Japan, focusing on RFID research. The approach taken by the Ubiquitous ID Center in Japan regarding RFID standards is similar in concept to that of EPCglobal. Their shared goal is to create a comprehensive standard system encompassing coding schemes, air interface protocols, and ubiquitous network architecture. However, there are differences in the specific content of each of these components. In the pursuit of developing RFID standards with independent intellectual property, the Ubiquitous ID Center in Japan introduced the uCODE coding scheme. This system is designed to be compatible with existing Japanese coding schemes while also accommodating other international coding systems. It consists of four main components: Ubiquitous Identification Code (Ucode), Information System Servers, Ucode Parsing Servers, and Ubiquitous Communicators. The primary frequency bands employed by UID are 2.45GHz and 13.56MHz.

It's worth noting that the RFID standards system developed by UID has not seen extensive adoption within the RFID industry in China, and its global influence is not as widespread as the RFID standards systems of ISO/IEC and EPCglobal.

4.AIM

AIM, which stands for the Global Automatic Identification Association, was established in 1999. AIM, on the other hand, represents the Automatic Identification and Mobility sector, focusing on expertise in automatic identification, data collection, and network infrastructure within mobile environments. It is a global organization with 13 country and region-specific branches. AIM has played a historical role in specifying universally accepted barcode standards and has also ventured into RFID standards. In November 2004, AIM, in collaboration with the American Electronics Association, announced a partnership to develop third-party certification for RFID.

Currently, AIM's influence in the field of RFID is not as extensive as that of EPCglobal.

5.IP-X

IP-X is indeed another Radio Frequency Identification (RFID) standardization organization, with a focus on being a third-world standards body for neutral sovereign nations. Its membership primarily consists of countries from regions such as Africa, Oceania, and Asia. IP-X's primary sphere of influence is in countries like South Africa and other similar nations.

6.NFCForum

The NFC Forum, established in 2004, is a nonprofit industry association initiated by major players in the mobile communications, semiconductor, and consumer electronics sectors. Its founding members include companies like HP, Mastercard, Microsoft, NEC, Nokia, NXP, Panasonic, Samsung, Sony, and others. The NFC Forum has officially defined the technical architecture of NFC and, to date, has released 26 specifications. The primary mission of the NFC Forum is to ensure interoperability between various devices and services by developing standards-based specifications. It encourages the use of NFC Forum specifications in product development and promotes NFC technology for the global market, thereby driving the widespread adoption of near-field communication (NFC) technology.

7.RAIN RFID

RAIN RFID is a global alliance with the mission of promoting the widespread adoption of UHF RFID technology. Currently, there are more than 160 members worldwide. RAIN RFID members include suppliers, organizations, academics and end users. RAIN utilizes the GS1 UHF Gen2 protocol standardized by ISO/IEC 18000-63, providing a universal protocol to ensure the use of consistent RFID Labels across the entire supply chain and reducing obstacles in the application of RFID Labels.

2 China's RFID standard system

In recent years, China has taken initial steps in the research and industrialization of RFID-related technologies and has commenced applications in select domains.

Notably, among the officially released national standards, there is limited coverage of core technologies, and there are relatively few RFID-related standards with indigenous intellectual property. The standards that have been issued predominantly focus on the application layer, such as GB/T 20563-2006 for Animal Radio-Frequency Identification Code Structure, GB/T 22334-2008 for Animal Radio-Frequency Identification Technology Guidelines, GB/T 22351 for Identification Cards, Contactless Integrated Circuit Cards, and Proximity Cards, among others.

Time	Development path	Details
2002	The National Information Technology Standardization Technical Committee's Automatic Identification and Data Collection Technology Sub-Technical Committee was established.Its secretariat is located at the China Article Coding Center	The three working groups of barcode,conformance testing,and radio frequency identification correspond to the five international working groups,carry out standardization research work corresponding to ISO/IEC/JTC1/SC31,and are responsible for the standardization of automatic identification and data collection technology and applications nationwide Work.
2007	The former Ministry of Information Industry issued the "Notice on the Release of Trial Regulations on the Application of Radio Frequency Identification(RFID)Technology in the 800/900MHz Frequency Band",delineating 840~845MHz and920~925MHzas the specific usage frequencies of RFID in the 800/900MHz frequency band	The issuance of this trial regulation removes technical application obstacles for the application of RFID in mobile commerce,mobile payment and other fields,allowing manufacturers and suppliers in China's RFID industry to provide corresponding products and services in a targeted manner,which is important for promoting industrial development., technological progress and nationalinformatization development are of great significance, and will also have a huge impact on the global RFID market as well as the supply chain,retail industry,and major product markets.
2010	Establishment of loT Standards Joint Working Group	It is composed of the Electronic Label (RFID)Standard Working Group of the Ministry of Industry and Information Technology,the Sensor Network Standard Working Group of the National Information Technology Standardization Technical Committee,the Information Resource Sharing Collaborative Service(IGRS)Standard Working Group of the Ministry of Industry and Information Technology,the National Industrial Process Measurement and The Control Standardization Technical Committee and other sectors of industry,academia, research and usersjointly initiated the establishment.
2024	The Radio Administration Bureau of the Ministry of Industry and Information Technology issued the "Radio Management Regulations for Radio Frequency Identification (RFID)Equipment in the 900MHz Band(Draft for Comments)"	It is stipulated that the frequency band used by domestic UHF RFID only retains 920~925MHz and removes 840~845MHz.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

AIoT星图 研究院

SILION 芯联

IMPINJ Partner Network
GOLD

About SILION TECH

SILION TECH is a professional RFID technology service provider in the field of the Internet of Things. The core team has more than 19 years of industry experience in RFID and the Internet of Things. Since the establishment of the company team in 2005, SILION TECH has been providing global leading RFID products and comprehensive solutions to customers in various fields and directions such as logistics supply chain management, asset management, production and manufacturing management, anti-counterfeiting tracing management, personnel management, vehicle management, and embedded application products.

SILION TECH is also a global leader in RFID chips as a global gold partner of Impinj Inc., a leading RFID chip company headquartered in the United States. Over the years, the company has worked closely with Impinj Inc. to provide ultra-high frequency RFID products based on Impinj's RF chips to customers around the world.

Why buy UHF/RAIN RFID modules from SILION TECH?

• Easy to pair with your devices. Our modules can be integrated with compatible fixed and mobile devices on your site. They operate in UHF ranges and can be set up for a range of antennas.

• Upgraded with the latest RFID chips. SILION TECH UHF RFID modules use Impinj chips for longer reading distances and RAIN connectivity. These make for the highest-performance RFID solutions across many industries.

• Incredibly versatile. Retail, logistics, manufacturing, and even healthcare organizations can benefit from bringing our modules into their day-to-day operations. They allow you to quickly locate assets, obtain real-time temperature readings of your machinery, track your inventory, and more.

• Affordable to implement. SILION TECH's RFID modules offer high cost-performance ratio, which can help you adopt RFID technology more quickly and extensively. A modest one-time investment makes your business closer to the efficiency of tracking, managing, and monitoring assets through RFID.

SIM7200 + SLD1090
RFID Gate

SIM7400 + SLD1010
RFID Smart Shelves

SIM7100
RFID PDA

SIM7300 + SLD6020
RFID Vending Machine

SIM3500 + SLD1040
RFID Self-Checkout Terminal

RFID Application: Smart Retail

SIM3100 + SLD1030
RFID Inventory Reader
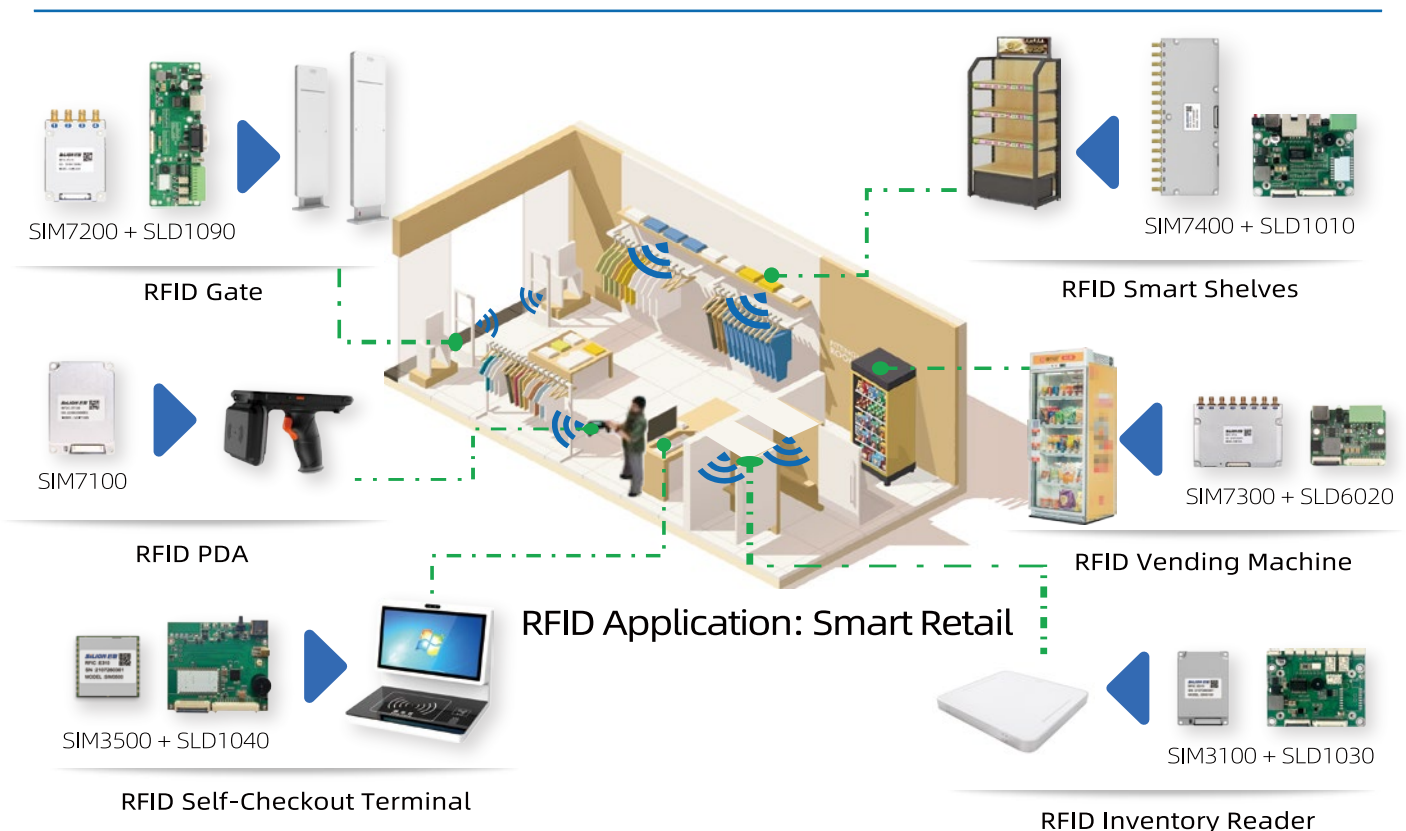
For more RFID products and solution details please visit our official website **en.silion.com.cn** to get more informational content.
Scan the QR code below to visit our webisite now!

Part 2
Analysis of China's UHF RFID industry

UHF RFID working band is generally between 860 ~ 960MHz, the frequency band in different regions of the world is slightly different, the frequency band in North America is 902 ~ 928MHz, the frequency band in Europe is 865 ~ 868MHz, and the frequency band in Japan is 916 ~ 924MHz. China delimits the frequency band range of UHF RFID communication is 920 ~ 925 MHz.

Compared with RFID products in other frequency bands, UHF RFID Labels have a relatively high transmission rate and can be read in a group to read a large number of electronic Labels in a very short time. Therefore, it is very suitable for large-scale application scenarios, and has obvious benefits for improving the management efficiency of supply chain.

With the maturity and perfection of the industrial chain in recent years, the cost of UHF RFID has been greatly optimized, so the use of UHF RFID Labels is also growing rapidly. At present, UHF RFID products are the most widely used, with the largest shipments and the largest number of industry chain players among several RFID frequency bands, and they also receive the most attention.

2.1 Analysis of China's UHF RFID industry chain

China is the main producer of UHF RFID Labels and reader products, so the UHF RFID industry chain is mainly concentrated in the Chinese market. The Label products and reader products in the UHF RFID market are two completely different industrial chains. The Label products have low cost, high standardization, and focus on production links, while the reader products are characterized by high technical barriers, high customization, and focus on solutions.

UHF RFID Industry Chain
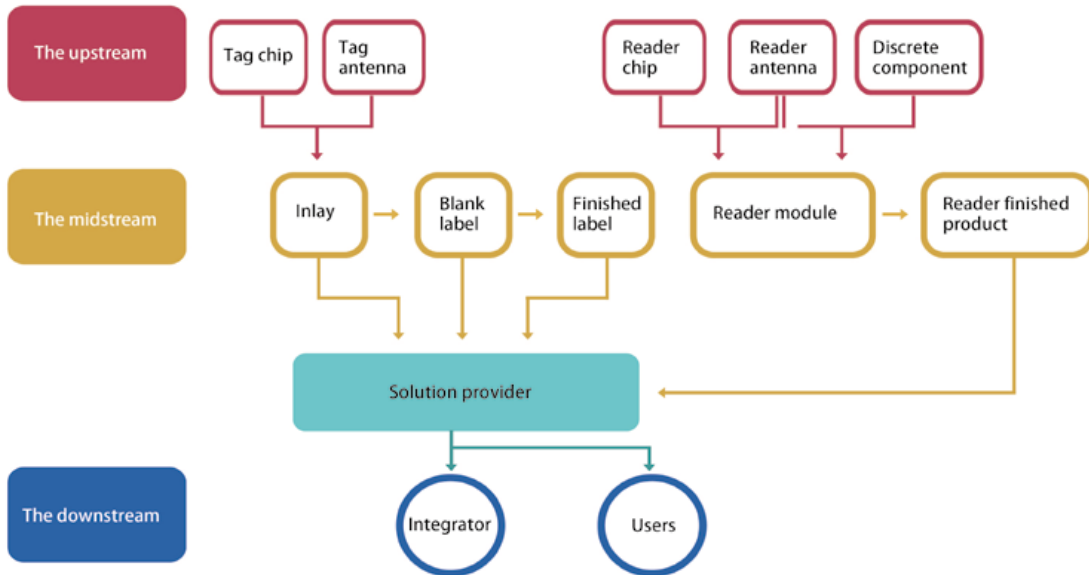
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.1.1 The upstream

UHF RFID's upstream includes chip manufacturers and antenna manufacturers. There are many UHF chip manufacturers, and you can refer to the "IOTE China RFID passive IoT industry map (2024 version)" in this report for specific players. In recent years, the domestic UHF RFID chip market has developed rapidly, with many new players emerging. In many application markets, domestic UHF chips have also gradually emerged.

The production of UHF Labels mainly adopts etching technology. Antenna is a link that emphasizes production. The production of antennas requires the use of large amounts of chemicals and heavy metals, which causes significant environmental pollution. In recent years, due to strict environmental protection policy supervision and the gradual reduction of antenna profit margins, many small factories have been eliminated, making the manufacturers of UHF Label antennas more concentrated.

In addition to etching antennas, environmentally friendly antenna technologies have gradually received attention in recent years. At present, common environmentally friendly antenna technologies on the market include cut-and-etch antenna, screen printing antenna, laser cutting antenna, etc. The technology maturity and market application of these environmentally friendly processes are gradually increasing.

In the UHF RFID reader chip market, the momentum of China's chip players is strong. Although high-end chips are mainly from overseas vendors, domestic chip players have become the mainstream in the mid-to-low end market. With the rise of domestic substitution, more and more capital and capable players are entering the UHF RFID chip field. In terms of product performance, the gap between domestic chip players and overseas vendors is gradually narrowing.

In addition, products that use discrete devices to build readers are also very common. Discrete devices can customize functions according to specific scenarios.

The market for UHF reader antennas is a very scattered one. Antenna performance has a significant impact on reader product performance, and antenna value accounts for a large proportion of reader products.

2 Summary of Main Manufacturers and Product Features of UHF RFID Label Chips

Chip manufacturers	Chip model	TID/UID area capacity(bit)	EPC area capacity(bit)	User area capacity (bit)	Sensitivity (dbm)	Product Features	Applicable scenarios
Kiloway	KX2005X-S	96-192	96-128	0	-23.5	No user area, high performance and low cost, high cost performance	Disposable hangLabels, delivery notes, labels, etc.; suitable for shoe newspapers, logistics, retail, etc.
	KX2005X-S+	96-192	96-128	64	-23.5	Small capacity user area, high performance and low cost, high cost performance	Disposable hangLabels, delivery notes, labels, etc.; suitable for shoe newspapers, logistics, retail, etc.
	KX2005X-544/512	96-192	96-240	544 /512	-23.5	Medium capacity user area, OTP can be written in, high cost performance	File management, asset management, etc.
	KX2005X-B	96-192	96-240	1312	-23.5	Large capacity user area, OTP can be written in, extremely high cost performance	Medicine/medical, asset management, animal management, etc.
	KX2005XG-S	96-192	96-128	0	-21.5	No user area, high performance and low cost, high cost performance	Retail, warehousing, single product management, etc.
	KX2005XG-544	96-192	96-240	544	-21.5	Medium capacity user area, OTP can be written in, high cost performance	Airline luggage, electric meter management, etc.
	KX2005XG-B	96-192	96-240	1312	-21.5	Large capacity user area, OTP can be written in, extremely high cost performance	Single product management, tobacco management, etc.
	KX2005X-BL	96-192	96-240	1312	-23.5	Passive LED lighting chip, long lighting distance, extremely high cost performance	Jewelry, archives, asset management, find and locate, etc.
	KX2005X-BT	96-192	96-240	1312	-23.5	Passive TD on-off detection chip, ultra-long reading distance, extremely high cost performance	Electric seals, electronic seals, anti-counterfeiting traceability, etc.
	KX2005X-BR	96-192	96-240	1312	-23.5	Anti-medical radiation chip, ultra-long reading distance, extremely high cost performance	Medicine/medical, products, pesticides, etc.

Chip manufacturers	Chip model	TID/UID area capacity(bit)	EPC area capacity(bit)	User area capacity (bit)	Sensitivity (dbm)	Product Features	Applicable scenarios
Kiloway	ONLY 1	None	96-128	None	-24.5	Single-ended dipole antenna factory-coded S-EPC, read-only, not writable; Extremely simple application, reducing label coding steps; High cost-effectiveness, ultra-low cost	Ultra-low-cost disposable applications, suitable for footwear, logistics, retail, etc.
	ONLY 2	None	96-128	None	-23	With dual-end dipole antenna, omnidirectional recognition direction performance is better; Factory-written S-EPC code, read-only, not writable; Extremely simple application, reducing the label coding process; extremely cost-effective, ultra-low cost	Ultra-low-cost disposable applications are suitable for complex stacking and dense group reading scenarios, and meet the high-difficulty identification and group reading applications such as retail, parcels, and warehouse goods.
	KE2006	96	96-128	0	-19.5	Single-ended dipole antenna, strong compatibility, low cost	Books/archives, intelligent manufacturing, asset management, etc.
Fudan Microelectronic	FM13UF0051E	96	160	32	Read:-24 Write:-23		Shoe and clothing inventory,supermarket retail,intelligent manufacturing,express delivery list
	FM13UF011E	96	128-512	512	Read:-24 Write:-23		Library management,shoes and clothing, airport luggage
	FM13UF011X	96	128-512	512	Read:-23 Write:-21		shoes and clothing,airport luggage
	FM13US02G	96	128	1664	Read:-19 Write:-17	Support GB/T 29768-2013	High value material management,anti-counterfeiting traceability,documents, transportation
	FM13UF02G	128	256	1536	Read:-19 Write:-17	Support GB/T 29768-2013	Logistics,warehouse management, vehicle and personnel management
Shanghai Quanray Electronics	Qstar-7U (S7U)	96	144	128	Read:-24 Write:-21	Low cost Ultra high sensitivity	Retail of shoes and clothing,e-commerce logistics
	Qstar-7X (S7X)	96	96-496	64-512	Read:-21 Write:-17	Omnidirectional antenna, high sensitivity	Logistics,aviation luggage,asset management
	Qstar-6T (S6T)	128	528	2K	Read:-19 Write:-13	Temperature sensing,LED, national security,2K user area	Asset health management,passive temperature detection
	Qstar-5X (S5X)	256	528	512/1K/ 1.5K/2K	Read:-19 Write:-11	2Khigh-capacity user area, IATA standard	Asset management,aviation assets
	Qstar-5R (S5R)	208	528	8K/16K/ 32K/64K	Read:-17 Write:-12	Up to 64K high capacity Supports GB/T 29768-2013	Asset management,passive sensing
Nation RFID	NRTC-806	64	64	1728	Better than-15dBm	Low power consumption, strong anti-interference, and high security	Customs,logistics,tobacco, transportation,etc
	NRTC-606	96	256	512	Better than-15dBm	Low power consumption, strong anti-interference, and high security	Railway,asset management,jewelry, logisticstracking and other fields
	NRTC-906	64	64	512	Better than-17dBm	Supports GB/T 29768 protocol	Material management,hazardous material management,anti-counterfeiting traceability,etc
T-HEAD	Yuzhen600		96		Read:-21		Smart retail,smart logistics,aviation,package tracking,inventory management etc
	Yuzhen611	96	128		Read:-24 Write:-20		Smart retail,smart logistics,aviation package tracking,inventory management,etc

Chip manufacturers	Chip model	TID/UID area capacity(bit)	EPC area capacity(bit)	User area capacity (bit)	Sensitivity (dbm)	Product Features	Applicable scenarios
MaxWave Micro	MW8113	96	128	32	Read:-20 Write:-16	Ultra Low Cost High yield rate High sensitivity	Retail of shoes and clothing, E-commerce logistics, Asset supervision.
	MW8115	96	128	32	Read:-22 Write:-18	Ultra Low Cost High yield rate High sensitivity	Retail of shoes and clothing, E-commerce logistics, Asset supervision.
Suzhou HC Tech IOT Technology	SWP-U1	96	128	0	Read:-23 Write:-19.5		
	SWP-U1M	96	128	128	Read:-23 Write:-19.5		Retail, Logistics, and Traceability
Zhejiang Johar Technology	LTU3	128	96		-18	Integrated temperature sensor	Electricity, industry, etc
Yingxin Semiconductor Technology	C799	96	128	512	Read:-23 Write:-21		Airports,healthcare,manu facturing,and automotive industries,among others
	C899	96	128	32	Read:-23 Write:-20		Anti counterfeiting certification and traceability,asset management,supply chain automation,etc
Huada Evercore	CIT86256	96	256	1264	Read:-18 Write:-16	Supports GB/T 29768-2013	Asset management,warehousing and logistics
	CIT86256A	64	32	1280	Read:-18 Write:-16	Supports GB-T35788-2017	Special for automotive electronic identification
IMpinj	Monza 4QT		128	512	-19.5		Industrial manufacturing,supply chain management,logistics,etc
	Monza 4E		496	128	-19.5		Industrial manufacturing,supply chain management,logistics,etc
	Monza 4D		128	32	-19.5		Industrial manufacturing,supply chain management,logistics,etc
	Monza R6		96	None	-22		Retail,healthcare,hotels,supply chain,and logistics,among other
	Monza R6-P		96/128	64/32	-22		Retail,healthcare,hotels,supply chain,and logistics,among other
	M730		128	0	-24		Retail,supply chain logistics,etc
	M750		96	32	-24		Retail,supply chain logistics,etc
	M770		128	32	-24		Retail,supply chain logistics,etc
	M775		128	32	-24		Retail,supply chain logistics,etc
	M780		496	128	-23.5		For high-capacity storage scenarios
	M781		128	512	-23.5		For high-capacity storage scenarios
	M830	96	128	0	Read:-25.5. Write:-20		Retail,supply chain logistics,etc
	M850	96	96	32	"Read:-25.5. Write:-20"		Retail,supply chain logistics,etc
	MonzaX-8K			8192	-21.6		Industrial scene

Chip manufacturers	Chip model	TID/UID area capacity(bit)	EPC area capacity(bit)	User area capacity (bit)	Sensitivity (dbm)	Product Features	Applicable scenarios
NXP	U9XE	96	128	0	"Read:-24 Write:-22"	High sensitivity	Supermarket retail, aviation luggage, express logistics, etc
	U9	96	96	0	"Read:-24 Write:-22"	High sensitivity	Supermarket retail, aviation luggage, express logistics, etc
	U8	96	96	0	"Read:-23 Write:-18"	High sensitivity	Supermarket retail, aviation luggage, express logistics, etc
	U8M	96	96	32	"Read:-23 Write:-18"	High sensitivity	Supermarket retail, aviation luggage, express logistics, etc
	UCODE DNA	96	224	3072	"Read:-19 Write:-11"	Combining encrypted AES authentication with long distance reading range	Automatic vehicle identification, intelligent logistics, brand protection
	UCODE DNA Track	96	448	256	"Read:-19 Write:-11"		Automatic vehicle identification, intelligent logistics, brand protection
	UCODE 9xm	96	128\256\496	752\624\384	"Read:-24 Write:-22"	Large user memory to store data	Industry 4.0, Aviation
	UCODE 7xm/ UCODE 7xm+	96	448	1024	"Read:-19 Write:-12"	Large user memory to store data	Industry 4.0, Aviation
	Ucode G2iM		256	512	-17.5		Retail, electricity, etc
EM	EM4124	64	96		Read:-21		Supply chain management, asset tracking, etc
	EM4325		352	3073	Read:-21	Supports battery powered and integrated temperature sensors	Supply chain management, tracking and traceability, sensor monitoring, etc
	EM4126	32	208			Supports entry mode with good liquid penetration	Supply chain management, tracking and traceability, sensor monitoring, etc
	EM4227	48	416	1280/ 1792	"Read:-18.5 Write:-15.5"		Access control, product certification, etc
	EM4018	96	480	1984			Industry, automotive, aerospace, etc
	EM4152		480	1984	Read:-19.5	Compatible with capacitive/resistive sensing capabilities	Industry and Intelligent Manufacturing
ALIEN	Higgs 3		96-496	512	-18		
	Higgs 4		128	128	-18.5		
	Higgs-EC		128	128	-22.5		
	H9		96-496	688	-22.5		
	H10		96-128	32	-23		

3 Summary of Main Manufacturers and Product Features of UHF RFID Reader Chips

Chip manufacturers	Chip model	Air port agreement	Receiving sensitivity	Modulation mode	Card reading rate
Nation RFID Technology	GXR-01	EPCglobal UHF Class 1 Gen2 / ISO 18000-6C, ISO 18000-6B, GB/T 29768	-75dBm @30dBm	PR-ASK, DSB-ASK	>400 times/second
	GXR-02	EPC C1G2, ISO18000-6B/C National Standard GB/T29768-2013 (optional) National Military Standard GJB7377.1 (optional)	-90dBm @0dBm	PR-ASK, DSB-ASK	>400 times/second
	GXICR-1902	ISO 18000-6C/EPC C1G2, ISO 18000-6B, GB/T 29768-2013		DSB-ASK, PR-ASK	>400 times/second
MagicRF	M100	ISO18000-6C & EPC Class-1 Generation-2	-69dBm in case of local blocking at -10dBm	DSB-ASK	
	QM100	ISO18000-6C & EPC Class-1 Generation-2	-79dBm in case of local blocking at 0dBm	DSB-ASK	
Fudan Microelectroni	FM13RD1616G	EPC Global C1G2, GB/T 29768-2013 Agreement	-88dBm@33dBm	DSB-ASK, SSB-ASK	
	FM13RD1616E	EPC global UHF C1G2 / ISO 18000-6C	-88dBm@33dBm	DSB-ASK, SSB-ASK	
DONGXINYUANXI	TM200	ISO/IEC 18000-6C	Under self interference conditions of 10dBm,the sensitivity is betterthan-72dBm	DSB-ASK, SSB-ASK, PR-ASK	
	TM670	ISO/IEC 18000-6C, GB/T29768	Under self interference conditions of 10dBm,the sensitivity is betterthan-77dBm	DSB-ASK, SSB-ASK, PR-ASK	
lotelligent (Jiang Su)Technology	IBAT2000	EPCC1G2 (American Standard) ISO 18000-6B/6C ETSI EN 302208-1 (European Standard) GB/T 29768-2013 (National Standard) GJB 7377.1 (National Military Standard)	-85dBm(Self Jammer 10dBm) -96dBm(withoht Self Jammer)		>500 times/second
Yuxin Micro (Chongqing) Intelligent Technology	UC8688/ UC8688E	EPCglobal UHF Class 1 Gen 2/ISO 18000-6C, GB/T 29768-2013	-80dBm		630 times/second
IMPINJ	E310	RAIN RFID / ISO 18000-63 and EPCglobal Gen2v2 compliant	-75@10dBm Sensitivityof antenna reflection measurement		250 times/second
	E510	RAIN RFID / ISO 18000-63 and EPCglobal Gen2v2 compliant	-82@10dBm Sensitivityof antenna reflection measurement		700 times/second
	E710	RAIN RFID / ISO 18000-63 and EPCglobal Gen2v2 compliant	-88@10dBm Sensitivityof antenna reflection measurement		1000 times/second
	E910	RAIN RFID / ISO 18000-63 and EPCglobal Gen2v2 compliant	-94@10dBm Sensitivityof antenna reflection measurement		1000 times/second
PHYCHIPS	PR9200	ISO 18000-6C/EPC Gen 2	Sensitivity-60dbm under self interference conditions of -10dBm Sensitivity-85dbm without self interferenc		
	PR7	EPC Gen 2, ISO 18000-61/62/63	Maximum-86dBm(M8,250KHz) -84dBm(M4,250KHz)		Maximum 1000 times/ second(FM0,640KHz) 193times/ second(M4.250KHz)

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.1.2 The midstream of China's UHF RFID industry chain

The midstream of UHF RFID can be divided into two lines: Label product line and reader product line.

The Label product line covers the Inlay production link (packaging), blank Label production link (composite), spray printing link (post-process), and integrators.

UHF RFID Labels are very focused on production, which requires equipment. Therefore, manufacturers of Label production equipment also play an important role in the industry chain. The main production equipment includes packaging equipment (binding chips and antennas into Inlay), composite equipment(combining Inlay into white Labels), spray printing/printers, and testing equipment used in each link.

Label production is also a segment with high sales and low profits, so many label manufacturers choose to expand their business scope to cover diversified operations such as "binding + compound" or even "binding + compound + printing" in order to increase their output value and total profits.

The product line of readers and writers in the midstream market includes reader modules, reader finished products, solution providers, and integrators. Among them, there are many types of reader finished products, including fixed readers, mobile readers, tablets, robots, printers, and others.

2.1.3 The downstream of China's UHF RFID industry chain

The downstream of the UHF RFID industry chain is various application end users and integrators. Although the application is downstream, it is the source of demand and the final payer of the entire industry chain closed loop. It can be seen that the downstream of the industry chain is in a crucial position in the entire industry chain. The application of UHF RFID can be divided into general market and customized market.

General and customized are relative concepts because the UHF RFID market is mainly targeted at B and G types of businesses, and each project has different requirements. In a certain sense, UHF RFID belongs to customized markets. For the purpose of better analyzing the ultra-high frequency RFID market, it is classified into general-purpose and customized types in this report.

General-purpose market refers to applications where the amount of UHF RFID Labels used is very large, and the requirements for such applications are relatively similar and can be easily replicated. Typical applications include footwear and clothing, retail supermarkets, aviation, logistics and express delivery, and libraries and archives. In these scenarios, UHF RFID Labels are used as consumables, so the amount consumed is very large, and the sensitivity to Label prices is relatively high.

Customized market refers to markets where the demand is not concentrated and the usage environment has customized requirements for the performance and appearance of Labels and readers, with low reproducibility. Typical applications include industry, power, healthcare, transportation, railways, washing, ticketing and card systems.

In terms of the proportion of Label consumption, the customized market cannot compare with the general market. However, this market has a higher demand for readers and better prices and profits, which can accommodate more players and make the entire RFID market more diverse and prosperous.

There is also an important category of players in the UHF RFID industry chain: integrators. RFID end-users mainly target B and G businesses, and RFID products serve as a submodule that usually directly interfaces with integrators.

2.2 China UHF RFID Passive Internet of Things Market Opportunity Model Analysis

In the previous version, we introduced the "market driving force model" and "market demand model" for the market analysis of RFID passive Internet of Things, and summarized the major segmented application markets of UHF RFID. In this year's version, we derived an "industry market opportunity model" based on the previous two models.

The industry market opportunity model is mainly judged from five dimensions, and in order to better quantify the market, we score each dimension (1-10 points):

1. Industry certainty: Comprehensively consider the policies of each sub-industry, the layout of industry giants, the driving forces and demand of the industry's market demand, and evaluate the certainty of the sub-industry. The higher the certainty, the higher the score.

2. Industry market ceiling: This dimension judges the upper limit of the market ceiling of UHF RFID in each sub-scenarios (based on shipments) to determine how large the potential market of the industry is. The higher the ceiling, the higher the score.

3. Industry standardization: This dimension judges the product standardization of UHF RFID in each sub-scenarios and whether it can be quickly

replicated and expanded. The higher the standardization, the higher the score.

4. Industry entry threshold: This dimension judges whether the entry threshold of UHF RFID in each sub-scenarios is high (including technology threshold, market qualification and resource threshold, capital and channel threshold, etc.). A high threshold means fewer players entering, relatively less competitive pressure, and relatively greater market opportunities. The higher the industry threshold, the higher the score.

5. The ability of UHF RFID technology to replace existing technology products: This dimension judges what are the existing solutions for each segmented scenario that UHF RFID wants to enter, and how UHF RFID technology can replace these existing solutions (the degree of improvement in technical performance, price level, etc.). If UHF RFID is an innovative application in a certain segment (that is, there are no other competing technical solutions), it means that UHF RFID is scarce in this field, and the score for this item will be relatively high. The stronger the ability of UHF RFID to replace other technologies, the higher the score.

4 China UHF RFID Industry Segment Market Opportunity Analysis Model

	Degree of certainty	Market ceiling	Degree of Standardization	Barriers to entry	Ability to replace existing technologies	Total score
Shoes and clothes	10	10	9	5	9	43
Supermarket	9	10	7	5	8	39
Express delivery	7	10	9	5	8	39
Air baggage	7	5	7	5	7	31
Books and archives	7	6	6	6	7	32
Alcoholic product	5	5	5	7	7	29
Electricity	6	4	4	8	6	28
Auto parts	5	6	4	7	6	28
Jewelry	3	5	4	6	5	23
Laundry	3	5	3	6	5	22
Medical	3	5	2	7	4	21
Asset management	3	7	2	5	5	22
Animal management	3	5	3	5	4	20
Industrial production line	3	6	3	6	4	22
Tickets and cards	3	4	5	5	4	21
Food & medicine	2	10	7	5	5	29
Electronic products	2	7	6	6	4	25

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

According to the market opportunity model of UHF RFID, we can summarize the following points:

The first-tier segmented application scenarios include: shoes and clothing, supermarket retail, express logistics, and these segmented scenarios are also the mainstream scenarios for the current RFID Label shipments.

The second-tier segmented application scenarios include: airline baggage, books and archives, wine and beverages, electricity, auto parts, food and medicine. Although the total scores of these application scenarios are similar, the distribution of the five scores varies greatly. For example, food and medicine have great potential, but there is not much explosion at present; and although the scores of industries such as electricity and auto parts are not high in terms of industry shipment ceiling and industry certainty, they score relatively high in terms of industry entry barriers. The second tier is an application scenario worthy of attention and expectation.

The third-tier application scenarios are more scattered. Although they are scattered and the volume of a single project may not be large, such a segmented market can maintain a high profit level, and the added market output value should not be underestimated.

2.3 Analysis on the Operation of China's UHF RFID Industry Market

The product line of UHF RFID is divided into two major categories: Labels and readers. In terms of quantity, the number of Labels is several orders of magnitude higher than the number of readers. Therefore, in order to better reflect market information, in this report, the Labels and readers will be analyzed separately.

In our research, we found an interesting phenomenon: certain application scenarios are mainly driven by Label manufacturers, while certain scenarios are clearly driven by reader manufacturers. The reason for this phenomenon lies in the ratio of readers to Labels.

When the proportion of readers is relatively large in a certain field, reader manufacturers have the driving force to expand that market. When Labels dominate in a certain field, Label manufacturers have the driving force to expand that market. Based on market research information, we conducted a model analysis of the market as shown in the following table:

5 Analysis model of Label market and reader market

Number of readers number of Labels	Typical Scenario	Label-type market or reader-type market?
Up to 1:1000	The scale of the projects is relatively divided,with either very small and scattered projects such as some special markets,where the single project volume is not large but the profit is good,or large-scale industrial or government projects such as production workshops,electric vehicle management,and garbage classification.	In the reader-based market,the investment in readers accounts for a larger proportion of the project.For some projectsthat require special labels,the outputvalue of labels accounts for a relatively high proportion,so special labels also pay more attention to this type of market.
1:1000~1:10000	Industrial-grade scenarios,national/military standard asset management, power asset management,medical care,cloth washing,etc.	The interval is stilldominated byreader and writer manufacturers,but some project Labels have relatively large output values,especially special type Labels, which willalso actively focUs on this market.
1:10000~1:100000	Books and archives,airport luggage,express logistics and so on	The overall market is a label-based market,but some of it will still be dominated by project reader and writer manufacturers.
elow 1:100,000	Retail	It's a Label-based market,the main hardware investmentin this scenario is Labels,with a small proportion of investment in readers and writers.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.3.1 Label Market

1 Global UHF RFID Label Shipments

Generally speaking, when a market becomes mature or its base grows larger, its growth rate tends to slow down. However, in the UHF RFID Label industry, as the base continues to expand, the growth rate shows an accelerating trend, which is rare and fully illustrates that UHF RFID Labels are entering a golden age of development.

This report evaluates the global UHF RFID Label shipments from the perspective of Label chips.

6 Global UHF RFID Label shipments (Unit: 100 million)
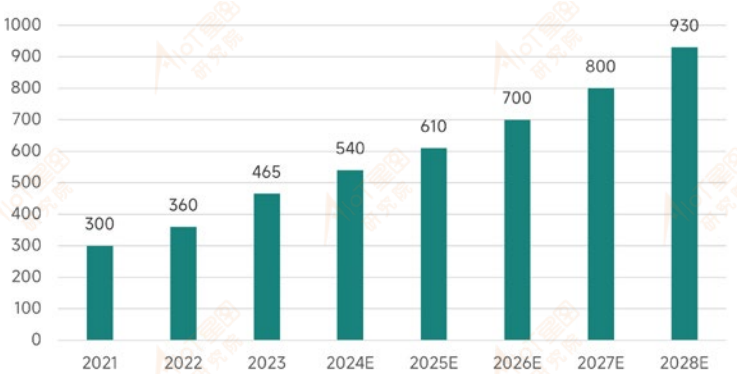
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. In last year's version, we made an optimistic forecast for the shipment of UHF RFID Labels, but still underestimated its growth. According to the statistics of the RAIN Alliance, the shipment of UHF RFID Label chips reached 44.8 billion in 2023 (mainly NXP and Impinj data). Based on this data, combined with the shipment data of domestic UHF RFID Label chip manufacturers we surveyed, we updated the global overall UHF RFID Label chip shipment data.

2. The biggest contributors to the substantial growth in 2023 are the two major projects of Walmart and UPS. Walmart has increased the SKU category of RFID Labels, and UPS has popularized RFID Labels in express parcels at the single item level. The growth brought by these two major projects is close to 10 billion pcs. In the next few years, without the stimulation of such large projects, we estimate that the overall growth will slow down, but it is expected to maintain a compound growth rate of more than 10% in the next few years.

3. According to this growth trend, the global UHF RFID Label market is expected to have an annual shipment volume of more than 100 billion pieces around 2030.

4. The biggest variable in the future UHF RFID market is the express parcel field. At present, at the policy level, the State Post Bureau is promoting RFID Labels, and among the industrial forces, JD.com, SF Express, Cainiao and STO Express are actively trying. At present, in the domestic express logistics system, RFID Labels have been widely popularized in transit bags, and it is still necessary to overcome many difficulties to achieve the popularization of express single items. However, the number of domestic express parcels is very large, reaching 132 billion in 2023, and the market concentration is high. Once popularized, large-scale implementation can be achieved in 2-3 years. We will continue to pay attention to the latest developments in this market in the future. If there is certain news, we will update the data as soon as possible.

The biggest difficulty in popularizing RFID Labels in the domestic express parcel market is the cost, because the unit price of domestic express parcels is too cheap and the profit is very thin. The leading express delivery companies are also actively trying to popularize RFID Labels. For example, JD.com has been popularizing single-item RFID Labels in its own large warehouses; Cainiao uses RFID Labels in international express delivery in Europe, etc., but it will take a long time to fully popularize RFID Labels.

2 Distribution of domestic chips and overseas chips in the global UHF RFID Label market

The UHF RFID Label chip market has a large volume, and in recent years, with the rising trend of domestic substitution, more and more players have entered this market and begun to be accepted and recognized by the market.

7 Distribution of Domestic and Overseas Chips in UHF RFID Label Market(unit: 100 million)

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1.Foreign chip manufacturers have formed a duopoly situation between NXP and Impinj.

2.In recent years, many domestic chip players have entered the market. We have counted the following: Caravelle, Guoxin IoT, Shanghai Kunrui, Pingtouge, Fudan Micro, Zhihui Xinlian, Zhixin Micro, Yingxin Semiconductor, Huicheng Xintong, Zhejiang Yuehe, etc. In addition, Alien can also be classified as a domestic brand. Some manufacturers already have large-scale applications, some manufacturers' chip products are just beginning to enter the market, and some chip products are targeted at specific markets.

3.The application scenarios of RFID Labels are often some single large projects that use very large quantities. We will pay close attention to market trends in real time, and if there are major data changes, we will update them in a timely manner.

3 Global UHF RFID Label market market distribution by major market segments

This white paper evaluates the shipments of several major market segments of global UHF RFID Labels, and the results are as follows:

8 Global UHF RFID Label market distribution by major market segments (unit: 100 million)
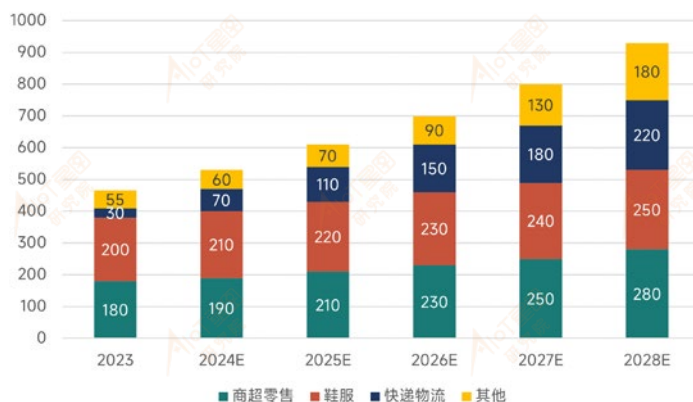
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. This data is newly tracked by us. In order to ensure the credibility of the data, we tracked it from 2023 onwards.

2. Because we are in contact with several major application markets in the global application market, the granularity of market segmentation is not so detailed. Several markets with large proportions are analyzed separately, and other market segments are put in "others".

3. Based on the information we have learned so far, the predicted growth of major market segments in the future is linear. If there is more clear information later, we will update it in time.

4. The global "other" market forecast is that in a few years, some new application scenarios will be unlocked in the market, and this field will become the main incremental market.

4 China's UHF RFID Inlay Production Volume

China is the main production base of UHF RFID Inlay. The next link of Inlay is compounding into Label, which is an auxiliary material for clothing retail. The production capacity will depend on the distribution of clothing factories.

The most core equipment for Inlay production is packaging equipment. At present, major UHF RFID Label manufacturers are actively expanding their production capacity. In this white paper, we evaluated the production volume of UHF RFID Inlay in China. Some special Label products use special production processes instead of standard Inlay products. The Inlay data of this white paper does not include the volume of such products. The volume of special Labels will be analyzed separately in this chapter.

9 UHF RFID Inlay production volume in China (unit: 100 million pieces) and global share (unit: %)
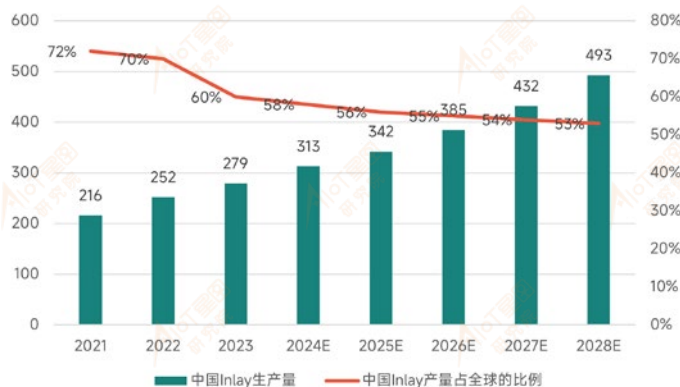
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. In the past few years, China's UHF RFID Inlay production capacity (including factories of overseas companies in China) accounted for about 70% of the global total. In 2023, due to the official operation of some large factories, the domestic share of overseas Inlay production has dropped to about 60%. Although we have seen that domestic UHF RFID Inlay factories are also expanding their production capacity, overall, overseas production capacity expansion is faster, so the domestic share is expected to gradually decline. The regions with the fastest overseas UHF RFID Inlay production capacity expansion are North America and Southeast Asia.

5 Analysis of UHF RFID Inlay shipments by domestic manufacturers

Regarding the data of UHF RFID Inlay, there is another comparison value, that is, the shipment data of domestic UHF RFID Inlay companies (excluding companies with Hong Kong/Macao/Taiwan background)

10 Analysis of UHF RFID Inlay shipments by domestic manufacturers (unit: 100 million pieces)
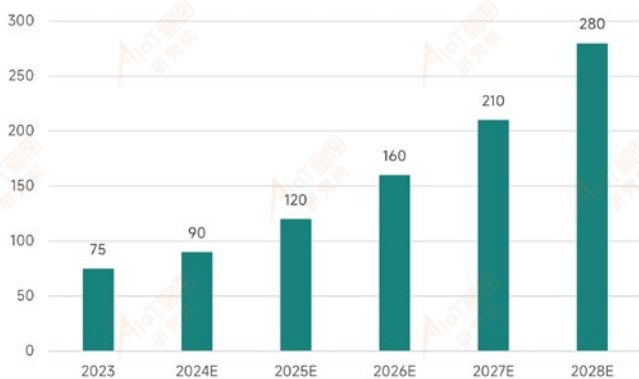
Data description:

1. This data does not include the quantity of special Labels. The production process of some special Labels is relatively special and does not use standard Inlay products, but such products account for a very small proportion.

2. Because this data is newly tracked by us, in order to ensure the credibility of the data, we track the year from 2023.

3. The estimated trend of domestic manufacturers' UHF RFID Inlay shipments is basically consistent with the shipments of domestic chip manufacturers.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

6 Analysis of ARC and non-ARC Inlay Market

Friends in the RFID circle are familiar with ARC certification. In recent years, we have seen the rapid growth of the RFID Label market, but this growth is mainly contributed by the ARC market. For domestic RFID suppliers, there are not many things they can participate in. They can only participate in the compounding and labeling of Labels, but not in the Inlay and chip links. Therefore, in this year's version, we evaluated the ARC and non-ARC certified Inlay markets.

11 ARC and non-ARC Inlay Market Analysis (Unit: 100 million pieces)
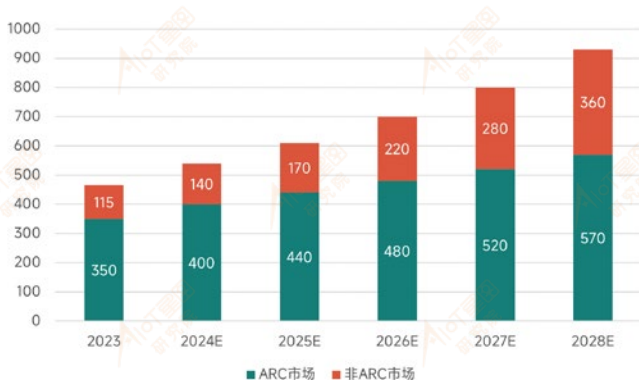
Data description:

1. This data is newly tracked by us. To ensure the credibility of the data, we tracked it from 2023 onwards.

2. ARC is mainly required by brands in the North American market, while brands in Europe, Japan and South Korea do not have mandatory ARC requirements. However, different brand manufacturers also have their own label performance requirement systems. According to the information we have surveyed, domestic Inlay manufacturers have also participated in projects for non-North American brands such as ZARA and Uniqlo.

3. At this sLabele, the ARC-certified market occupies the majority of the UHF RFID Label market, but we estimate that the non-ARC market will grow faster in the future.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

7 Analysis of domestic manufacturers' UHF RFID universal Label shipments

12 Analysis of domestic manufacturers' UHF RFID universal Label shipments (unit: 100 million)
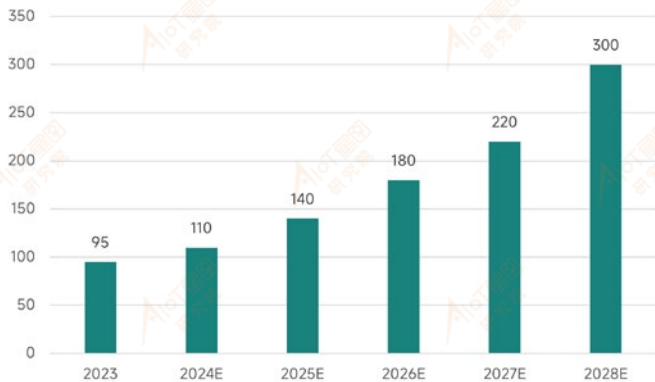
Data description:

1. This data is our newly tracked data. In order to ensure the credibility of the data, we tracked the year from 2023.

2. The evaluation logic of domestic enterprises' UHF RFID Label shipments is: domestic end users basically use domestic manufacturers' products, and considering the ARC market such as Walmart, its Label products are also supplied by many domestic companies. Therefore, some overseas end-user markets also use domestic Label products.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

8 Analysis of the UHF RFID Specialty Label Market of Domestic Manufacturers

During the research of this version of the white paper, we came into contact with many companies whose main business is RFID specialty Labels. The gameplay of such companies is quite different from that of general-purpose Labels. Therefore, this version will analyze the UHF RFID specialty market separately.

It should be made clear that the scope of our discussion is specialty Labels in the UHF frequency band, because there are also many specialty Labels in HF and LF, especially LF, whose Labels can be regarded as specialty Labels. This chapter focuses on UHF.

Compared to general-purpose RFID Labels with a high degree of automation in production process, RFID Labels with special packaging processes or materials are collectively referred to as RFID specialty Labels in the industry.

The common RFID specialty Labels on the market are:

Washing Labels: RFID Labels mainly used in the linen washing industry, whose antennas are mostly made of metal wires, and some special packaging processes are added for washability.

Flexible anti-metal Labels: Because metal easily absorbs electromagnetic waves, general RFID Labels cannot be directly attached to metal objects. In actual applications, many items that need to be managed are made of metal materials. Labels used in such scenarios are collectively called anti-metal Labels. The key to anti-metal Labels is to increase the insulation layer between the metal and the RFID Label. According to the difference in insulation materials, they can be divided into flexible anti-metal Labels (Labels can be bent) and hard anti-metal Labels (Label packaging materials are hard materials such as plastic and ceramic). Among them, flexible anti-metal Labels are a relatively common product, which is analyzed separately in this white paper.

Hard shell Labels: The outermost packaging material of the Label uses hard shells such as plastic and ceramic, which are mostly used in environments such as anti-metal, high temperature resistance, waterproof, and physical collision resistance. In addition, we also classify card-type UHF RFID Labels as hard shell packaged Labels.

PCB Labels: refers to RFID Labels that use PCB as the substrate and perform simple packaging. The appearance looks like a PCB board and is mostly used in industrial scenarios such as anti-metal and high temperature resistance.

Animal ear Labels: Animal ear Labels are usually packaged in shells. Since there are many such Labels, this white paper analyzes them separately.

Anti-transfer Labels: Use some special glue and substrate. Once the RFID Label is attached to an item, it will be damaged if it is torn off, thereby achieving the purpose of anti-transfer. Another type of label is attached to the bottle cap of alcoholic products, which will be torn off as the bottle cap is removed.

"RFID+X" labels: Common ones are RFID+ temperature sensors. There are mature products on the market. In addition, there are RFID+LED flashlights, RFID+ small speakers and other products, which are mainly used for close-range multi-Label search.

Based on the data we have surveyed, the shipment volume of China's special label market is summarized.

13 Analysis of domestic manufacturers' UHF RFID special Label market shipments (unit: 10,000)
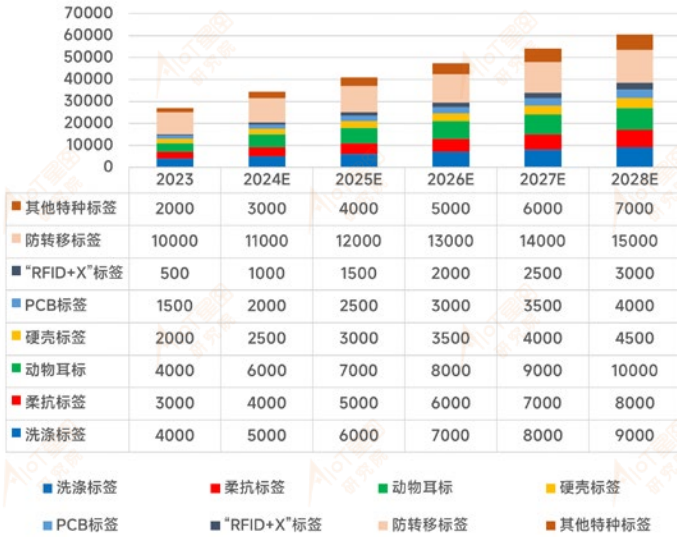
	2023	2024E	2025E	2026E	2027E	2028E
■ 其他特种标签	2000	3000	4000	5000	6000	7000
■ 防转移标签	10000	11000	12000	13000	14000	15000
■ "RFID+X"标签	500	1000	1500	2000	2500	3000
■ PCB标签	1500	2000	2500	3000	3500	4000
■ 硬壳标签	2000	2500	3000	3500	4000	4500
■ 动物耳标	4000	6000	7000	8000	9000	10000
■ 柔抗标签	3000	4000	5000	6000	7000	8000
■ 洗涤标签	4000	5000	6000	7000	8000	9000

■ 洗涤标签　　■ 柔抗标签　　■ 动物耳标　　■ 硬壳标签
■ PCB标签　　■ "RFID+X"标签　　■ 防转移标签　　■ 其他特种标签

Data description:

1. This data is our newly tracked data. In order to ensure the credibility of the data, we tracked the year from 2023.

2. The scope of this data statistics is the shipment volume of UHF RFID special label companies in China, and many of the application markets are exported overseas.

3. The volume of anti-transfer labels is relatively large, mainly because of the large volume of liquor projects such as Wuliangye and Moutai.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

9 Analysis of UHF RFID Label market application volume for domestic users in China

The application brands of UHF RFID Labels are mainly overseas customers, but how many RFID Labels are used by domestic end users each year? This version of the white paper analyzes this number, and the results are as follows:

14 UHF RFID Label application volume by domestic users in China (unit: 100 million pieces)
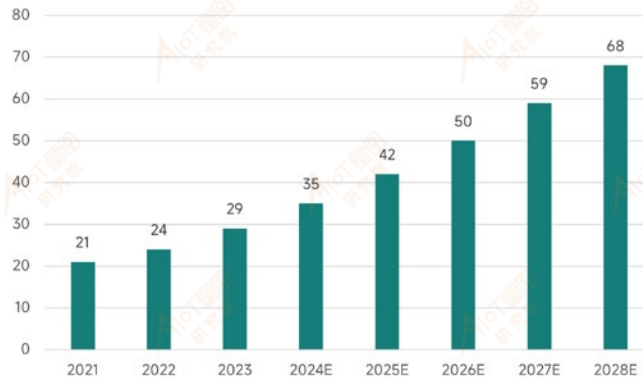
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. In the previous version, we tracked the shipment volume of the Chinese application market, so there is basic data, but in this year's version, we have divided the data granularity in more detail, and the demand of domestic terminal users is a new data we track.

2. Compared with the global shipment volume of UHF RFID Labels, the proportion of label usage by domestic terminal users is still very small, accounting for only about 6% in 2023. This data is completely disproportionate to the proportion of domestic supply chains, which is also an important factor in the domestic RFID industry volume.

3. We are still optimistic about the future growth of domestic terminal users, especially if there are continuous large orders in industries such as express delivery, medicine, and footwear and clothing retail, this number will grow rapidly.

4. Combined with the shipment volume data of the domestic special label market, although a large proportion of special labels are used in overseas markets, it can be seen that in the domestic UHF RFID terminal application market, the proportion of special label application scenarios is still very large.

10 Analysis of the UHF RFID Label application volume of overseas brands in the Chinese market

In the domestic application market, there is another important component, which is the domestic shipment data of overseas brands. This data has a great reference value for improving our understanding of the domestic RFID application market. Therefore, we list and analyze it separately.

15 UHF RFID Label application volume of overseas brands in the Chinese market (unit: 100 million)
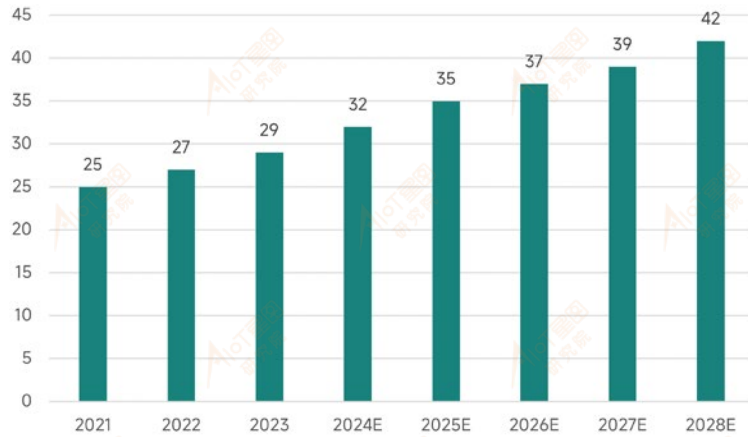
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. The calculation formula of this data is relatively complicated. The general logic is: Step 1: Evaluate the shipment volume of overseas brands based on the global total shipment volume and domestic application shipment volume; Step 2: Deduct the volume of the two largest single projects, Walmart and UPS (although Walmart has many suppliers that are domestic companies and RFID Labels are also produced in China, they are uniformly classified as overseas brands from the brand dimension); Step 3: Take a coefficient for the remaining overseas brands with business layout in China; Step 4: The remaining is the volume of overseas brands with layout in China. We take 20% for calculation based on the proportion of China's population and GDP.

2. Although the proportion of overseas brands in the domestic market is not large after layers of screening, at the current sLabele, this number is still higher than the total shipment volume of domestic brands and users. However, the domestic market layout of overseas brands is concentrated in the footwear and clothing retail industry, and the brand concentration is high. The future growth potential is not as great as that of domestic brands.

11 Analysis of the UHF RFID Label Market Segments in China's Domestic Users

In the last part of this chapter, we conducted a detailed analysis of the main application markets of UHF RFID Labels in the domestic user market. Compared with the previous version, we have a more detailed understanding of the data in many segments this year. Therefore, the data of many industries have been adjusted and updated. The results are as follows:

16 Main application market distribution of UHF RFID Labels for domestic users (unit: 100 million)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Retail	4.5	5.0	6.0	8.0	11.0	14.0	18.0	22.0
Express logistics	2.5	3.0	5.0	6.0	7.0	8.0	9.0	10.0
Books and archives	2.5	2.8	3.0	3.4	4.0	4.8	5.5	6.5
Air baggage	1.7	1.6	2.0	2.2	2.4	2.8	3.0	3.2
Jewelry and luxury	1.0	0.9	1.0	1.2	1.4	1.6	1.8	2.0
Electricity	2.1	2.5	2.6	2.8	3.0	3.2	3.4	3.6
Hotel linen	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5
Medical	0.8	1.3	1.5	2.0	2.5	3.0	3.5	4.0

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Industry	1.2	1.5	1.8	2.2	2.6	3.0	3.5	4.0
Alcohol	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
Tobacco	0.8	0.8	0.8	0.9	0.9	1.0	1.1	1.2
Animal management	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0
3C electronic products	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7
Tickets	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5
"RFID+X" Labels	0.01	0.02	0.02	0.05	0.05	0.1	0.1	0.2
Others	2.09	2.58	3.08	3.55	3.95	4.8	5.9	6.6
Total	21	24	29	35	42	50	59	68

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Additional information on market segments:

1 Retail

The shoes and clothing and supermarket retail market is currently the largest application market for UHF RFID Labels. Walmart is the largest single user in the industry, and the number of UHF RFID Labels used each year has reached tens of billions. In addition, ZARA, Uniqlo, Decathlon, Nike and other brands use billions of UHF RFID Labels each year.

Even with a huge base, this market still has considerable growth prospects. Take Walmart as an example. Currently, the project only uses RFID Labels for some products in stores in North America. Once more SKUs of Walmart use RFID Labels, or more regions outside North America use RFID Labels, the volume will increase many times.

In the Chinese market, in the past one or two years, we have seen a very obvious trend of RFID in domestic brands. At present, leading players such as Anta and Heilan Home have already launched RFID projects, and most of the top 100 players are also trying RFID solutions. In the next few years, we will gradually see that RFID will become the standard in the footwear industry.

2 Express logistics

In addition to retail scenarios, another market that deserves the most attention for UHF RFID is express logistics.According to the information we have obtained, UHF RFID Labels have been applied in batches in the transfer bags of the express industry, mainly for sorting. The ultimate goal is to install RFID Labels on every express package. Currently, logistics companies such as Cainiao, STO Express, SF Express, and JD Logistics are actively deploying.

According to data from the State Post Bureau, China's express parcel industry has maintained a high growth rate.

Statistics of China's express delivery business volume (unit: 100 million)
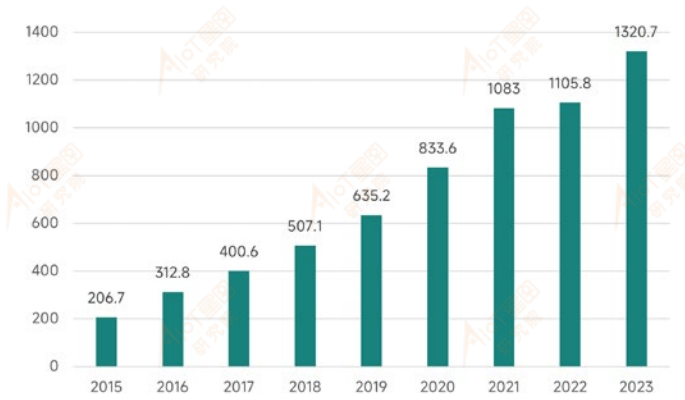
Source: State Post Bureau of China | Cartography: AIoT Xingtu Research Institute

Although the express delivery market has broad prospects, it still faces several problems:

Firstly, cost pressure. As the overall profit margin of the industry is very low, the industry's price expectations for logistics package labels are also extremely low. Even with domestic chips and existing manufacturing processes, label manufacturers' profits will be extremely low or even unprofitable, making it difficult to meet the price expectations of express delivery companies.

Secondly, there is the issue of production capacity. Once RFID Labels are fully adopted for logistics and express packages, the existing production capacity will not be able to keep up. Expanding production capacity (increasing packaging equipment) is also limited in speed.

At present, in the domestic express logistics industry, UHF RFID Labels have been widely used in transit bags. In addition, JD.com uses RFID Labels in large warehouses, and Cainiao has also begun to use RFID Labels in overseas packages. In the e-commerce cloud warehouse scenario, some cloud warehouses are also using RFID Labels.

The single-item express parcel is currently used by UPS in the United States, which provides a good reference case for the industry.

3 Book and archives

Book and Archives Market is another large market, which is divided into two parts.

One part is public library organizations, and the other part is general colleges and universities across the country. In addition, the total amount of government agencies and state-owned enterprises' archives is also large.

There are more than 3,000 public libraries in China, and the number of university libraries is between 6,000 and 8,000. In addition, the number of books in primary and secondary schools and community libraries is added, and the total number is tens of thousands.

We estimate that the total volume of the library collection market is about 10 billion books, and the corresponding Label demand is 10 billion. However, the library market has HF solutions and UHF solutions in parallel. The UHF solution is more suitable for this business scenario and its share is gradually increasing.

According to our research, RFID Labels are basically popularized in public libraries and major universities in economically developed cities. The next step is to sink the market to third- and fourth-tier cities and primary and secondary schools.

Therefore, there is still a certain increase in the market every year, and the book market will maintain an annual update rate of 5-10%. Based on the base of 10 billion books, even if the penetration rate reaches 100%, the annual update market demand for RFID Labels is 500 million to 1 billion. In addition to the library market, the archives market is also a market with great potential, especially for government departments and state-owned enterprises and institutions. Even after all documents are digitized, a paper document will be kept for archiving.

Theoretically, the volume of the archives market is large, but this scenario does not necessarily require RFID Label management, because many archives are not very important, and many archives are very thin, and it is also difficult to stack them together and use RFID for inventory. Therefore, we have seen that some important archives markets have begun to use RFID Labels for management.

4 Air baggage

Air baggage Labels are another relatively concentrated "consumable" market, and due to the promotion efforts of the Civil Aviation Administration, the adoption of RFID Labels in this field has been rapid in recent years, especially for large airports with an annual handling capacity of over 10 million passengers, most of which have adopted RFID luggage Labels.

In the aviation industry, in addition to baggage, RFID Labels have also begun to be widely used for aircraft maintenance tools and life-saving equipment for emergencies. Although the demand for these items is not as large as that for baggage, they require more customized product performance and have higher value.

As the main shipment volume is concentrated on air baggage, we can estimate the market size of this market by calculating the total number of airport passengers in China. According to data from the Civil Aviation Administration, domestic flights basically returned to pre-epidemic levels in 2023.

Based on a passenger throughput of more than 1 billion, the number of passengers is approximately 600-700 million, and the proportion of checked luggage is 30-40%, so the annual demand for RFID Labels for domestic airline luggage is approximately 200-300 million.

5 Jewelry & Luxury

Luxury brands, gold, jewelry, jade, jadeite and other valuable items have strong management needs due to their high value and consumption. Therefore, more and more jewelry brands are adopting UHF RFID Labels for management. Let's take the most commonly consumed gold as an example.

In a normal year, 700 tons of gold are consumed each year. The average weight of each piece of gold jewelry is 10 grams. The number of gold jewelry pieces is about 70 million pieces per year. Adding other valuable items such as silver jewelry, gemstones, jade, diamonds, and luxury brands,

the annual consumption potential of UHF RFID Labels in this market is about 500 million to 1 billion pieces. At present, some leading companies in the domestic jewelry industry are already using RFID Label management in batches, and in the field of luxury luggage brands, major overseas brands are also actively using RFID Labels.

6 Electricity

UHF RFID Labels are widely used in the power market. The most typical scenario is that each meter is equipped with an RFID Label for management. In a ddition, RFID Labels are also widely used in scenarios such as maintenance tools of the power system, distribution systems, and asset management within the power system.

The number of meters tendered by the State Grid fluctuates between 50 million and 90 million each year. Together with the number of meters in the Southern Power Grid, the average number of meters in the country is about 100 million per year.

Each meter has at least one RFID Label, and meters in some scenarios even have multiple RFID Labels, so the number of RFID Labels in the meter market alone is stable at more than 100 million per year.

Together with asset management in the power industry (maintenance tool inspection scenarios) and asset management in power warehouses, it is estimated that the number of Labels in China's power industry will be 200-300 million per year, and the demand for special Labels and readers is large, so the RFID output value of the power industry is high.

7 Hotel linen

There are two main applications of linen washing labels, one is the washing of hotel linens, and the other is the washing of hospital linens. Since we will analyze the application in the medical field separately, this section only analyzes the washing of hotel linens.

The hotel's laundry includes the laundry of bed sheets, quilts, pillowcases, towels and other items. Because these items have high requirements for cleaning, hotels will outsource them to companies specializing in laundry for cleaning. This brings about the problem of asset management and inventory, which also gave rise to the demand for UHF RFID Labels in this industry.

To evaluate the market capacity of UHF RFID Labels in the hotel laundry industry, we can analyze it from the perspective of the number of hotels and rooms in China. According to statistics, by the end of 2023, there will be 305,400 hotels in operation nationwide, with a room scale of 15.73 million.

According to our research, each hotel room requires about 30 UHF RFID Labels. Based on this estimate, the entire hotel linen industry requires about 450-500 million laundry Labels.

There are two main business models for hotel linen washing. One is that the hotel, as an investor, purchases RFID Labels to manage its own hotel's linen assets; the other is that third-party linen leasing companies use RFID Labels to achieve the purpose of asset management and leasing settlement.

Washing labels are not disposable consumables, but need to be reused. Generally, one label needs to be washed more than 100 times. In addition, washing labels are different from ordinary labels from chips to substrates to packaging. Therefore, the price of washing labels is relatively expensive, generally 1-3 yuan.

The total capacity of labels in the Chinese hotel market is about 450-500 million. Conservatively estimated, the proportion of companies that are able to invest in labels is about 20%, and the total market capacity of labels is about 100 million. Linen generally needs to be updated every 3 years, and the iteration speed of labels is also the same. Therefore, the number of labels in this market will remain at the level of tens of millions each year.

8 Medical

RFID Labels are widely used in the medical industry. According to our research, they are mainly used in the following scenarios:

The first category is hospital linens. Hospitals have strict management of operating costs, so the proportion of hospital linens that adopt the leasing model is gradually increasing.

Currently, there are about 8 million hospital beds in China. If each bed is estimated to have 10 pieces of linens, the number of RFID Labels required is about 80 million. Medical linens and hotel linens are two completely different markets. Since the investment in the medical market is related to policies and hospital strategies, it is not a fully competitive market. In addition, hospitals are very scattered, and different hospitals have different strategies. According to our estimates, there are millions of RFID Labels used in hospital linens every year, and they are still growing at a relatively high rate.

The second category is high-value consumables in hospitals, including heart stents, skeleton materials, experimental reagents, etc. According to our research, hospitals use the SPD model to manage such high-value consumables. SPD is a third-party management unit. They will deploy intelligent management equipment in the hospital. The manufacturer of high-value consumables will pre-place the consumables in the SPD equipment. When the hospital needs them, it will place an order through the SPD platform.

The business logic of this scenario is very consistent with RFID. According to our research, the SPD model is currently mainly used by tertiary hospitals. A tertiary hospital in a prefecture-level city generally needs about 10 RFID smart cabinets. The number of large hospitals in provincial capitals may be 20-30.

And how many tertiary hospitals are there? According to the data of the National Bureau of Statistics, there will be 3,523 tertiary hospitals in China in 2023, including 1,716 tertiary hospitals. Based on the most conservative calculation based on the number of Class III hospitals, the industry demand is more than 20,000 RFID smart cabinets. If calculated based on the number of Class III hospitals, the industry demand is approximately 40,000 to 50,000 RFID smart cabinets.

If the scope is expanded to hospitals nationwide (excluding grassroots hospitals and health institutions), the number of hospitals will reach 39,000, and the demand for RFID smart cabinets will be hundreds of thousands. (Of course, it is still slow for hospitals below the municipal level to popularize the SPD model).

In addition to the demand for RFID smart cabinets, how much is the demand for Labels?

According to our understanding, a tertiary hospital currently consumes about 1,000 high-value consumables per day, that is, 1,000 RFID Labels, and a hospital consumes about 300,000 to 500,000 RFID Labels in a year.

Because the unit price of RFID Labels is low, the demand for RFID Labels in all individual hospitals is not large, but if all tertiary hospitals are popularized, the consumption of high-value medical consumables RFID Labels in the country in a year can be 500 million to 1 billion, which is quite considerable.

The third category is blood bags, which are also medical consumables, but blood requires a professional environment for storage and transportation, so the SPD model is not applicable. However, this scenario also needs to be supervised by RFID.

It has also begun to be popularized in tertiary hospitals. It is understood that the annual use of blood bag RFID Labels in the country is tens of millions.

The fourth category is the management of medical equipment, including expensive testing instruments, surgical instruments, etc. The volume of these scenarios is relatively scattered, and the volume of a single project is not large.

9 Industry

In recent years, we have seen many domestic industrial production projects popularizing the use of RFID Labels. The scenarios of RFID Labels used in the field of industrial production include:

Production line carrier process management. Many subdivided industries require traceability data for the processes in the product production process to understand which processes the product has gone through in the production process. Under such requirements, it is necessary to add an RFID reader to each process, and each process has an RFID Label to track, but because the types of product accessories are not standardized and for cost considerations, the pallets or carriers for transporting accessories are usually managed.

Production line warehouse management mainly manages the inventory of raw materials and products for industrial production, and most of them also add RFID Labels on the carrier.

In addition, some factories also produce by attaching RFID Labels to products.

We understand that the current application scenarios where RFID Labels are used more in industrial production include automobile manufacturing, mobile phones, home appliances and other electronic products, battery manufacturing, photovoltaics, screens and other important parts.

The amount of Labels used in a single project in an industrial production scenario is not large, but the total amount is still considerable. Labels are mainly used on vehicles, which are generally scrapped after multiple turnovers. The cost of a Label after multiple uses is very low. However, the number of readers and writers required in industrial scenarios is large, and there are many projects with tens of thousands of readers and writers, and even a single project with hundreds of thousands of readers and writers.

10 Wines

There are many wines that use RFID Labels in the domestic market, the most typical of which are Moutai and Wuliangye. However, Moutai uses the HF solution, which is not within the scope of this chapter. Wuliangye uses the "UHF+HF" dual-frequency solution, so it can be discussed in this chapter.

It is understood that Wuliangye has currently used RFID Labels on about 30 wines, and the annual usage of Labels is tens of millions. In addition to Wuliangye, other domestic wine brands do not use RFID Labels on single-item projects, but use RFID Labels on large items or transport vehicles. The main needs they solve are anti-counterfeiting and anti-mixing.

11 Tobacco

Although the application of RFID Labels for single-item cigarettes has been delayed, some tobacco companies in some provinces have previously tried to add RFID Labels to each cigarette, but for various reasons, they were eventually abandoned

However, we have seen that the tobacco industry has used RFID Labels on a large scale in the management of tobacco leaves during the production process. After the tobacco leaves are purchased, they will be classified according to the requirements of different quality tobacco and fermented in specific processes, so the entire process needs to be managed.

Such a scenario is also to attach RFID Labels to the container carrier or large package of tobacco leaves, and the annual volume is close to 100 million pcs.

12 Animal Management

Combined with the characteristics of UHF RFID Labels, the main applicable scenarios for animal management are ear Labels and other non-in vivo injection Labels, as well as scenarios with large-scale asset management needs.

The animals that can use RFID Labels are mainly pigs, cattle and sheep, and the largest number of them is pigs. China's annual output of live pigs is about 700 million.

13 3C electronic products

According to our research, it is common to use RFID Label carriers for process management during the production of 3C electronic products, but there are not many projects that add RFID to the circulation and sales of products after production.

At present, only a small number of projects are trying to use RFID Labels to solve the needs of anti-counterfeiting and anti-mixing, as well as asset inventory and inventory management.

Although the current usage is small, we are still optimistic about this field because the volume of electronic products is large (adding up to tens of billions of levels), and the unit price is relatively expensive, so RFID Labels can be used.

14 Tickets

Damai.com and other channels are actively using RFID Labels to manage tickets for events and performances, and this scenario uses UHF RFID Labels to trace the sold tickets for anti-counterfeiting.

The market has a stable volume of tens of millions per year.

15 "RFID+X" Labels

The function of a single RFID Label is very simple, mainly simple ID information, plus some simple status data, and these data need to be written in advance, so RFID is also a passive sensing technology.

The "RFID+X" Label combines the passive capability of RFID with other sensors to give RFID Labels more capabilities. The most typical products are RFID+ temperature sensors and RFID+LED flash products.

At present, the volume of these two types of products is still relatively small, but this type of product is an innovative highlight of the industry. It can unlock some scenarios that RFID could not be used before. Therefore, this white paper still lists and analyzes it separately.

16 Other applications

In addition to the above-mentioned market segments, there are some application areas that are also worth looking forward to.

First of all, there are special markets such as national/military standards. Due to management needs, the national/military standards field has also been actively popularizing RFID Labels in recent years for the management of logistics materials, equipment, etc., with an annual volume of nearly 100 million.

Secondly, asset management is also an important application. Asset management is a relatively broad concept. Many of the application fields listed above can be classified as asset management, but in addition to the above-mentioned large-scale scenarios, there are many more scattered application scenarios.

In addition, electronic license plates, container management, enterprise inventory management, campus management of experimental equipment, etc. are also popularizing UHF RFID Labels, and the total volume is still relatively large.

2.3.2 Reader/Writer Market

1 Analysis of Global UHF RFID Reader/Writer Shipments

For the evaluation of the total number of readers/writers, this white paper starts from the perspective of reader/writer chips, because reader/writer chips are at the top of the industry chain and have a high degree of concentration.

Therefore, this white paper first evaluates the entire market volume from the dimension of UHF RFID reader/writer chips. There are still many UHF RFID readers/writers on the market that use discrete devices, not standard ICs. This is also a part of the reader/writer market, so it is also included in the research scope of this white paper.

Based on the comprehensive research information, we evaluated the shipment volume of the entire UHF RFID reader/writer, and the results are as follows:

17 Global UHF RFID reader market volume (unit: 10,000)
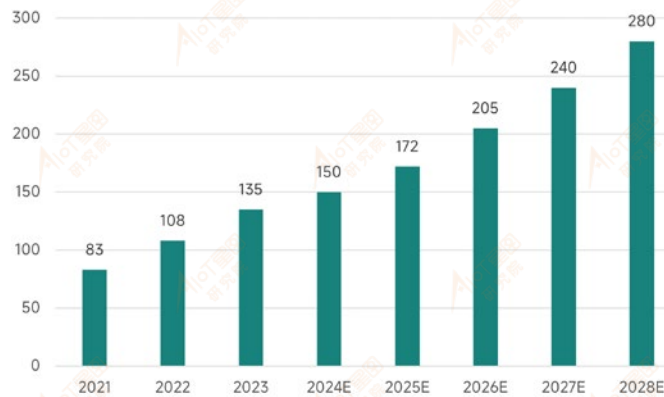
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. Compared with the previous version, we have updated the reader shipments in the past few years and future growth expectations.

2. The manufacturers of readers are mainly in China. In recent years, some large projects have been implemented, which is the main driving force for the growth of reader products.

2 Analysis of domestic chips and overseas chips in the global UHF RFID reader market

18 Distribution of shipments of domestic chip solutions, overseas chip solutions, and discrete device solutions in the global UHF RFID reader market (unit: 10,000)
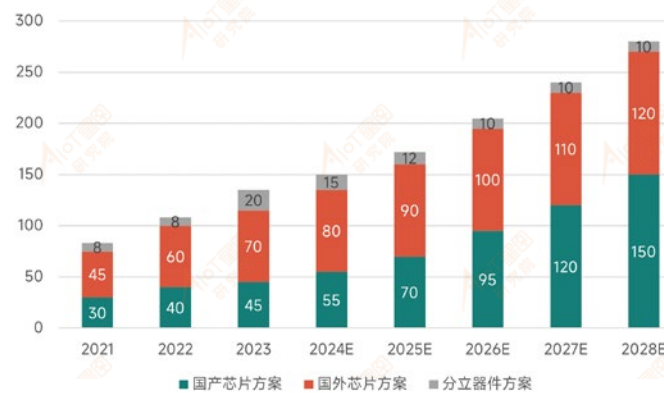
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. In the past few years, the amount of domestic UHF RFID reader chips was relatively small, and they were mainly used in low-end and mid-end scenarios. However, in recent years, the development speed of domestic chips has accelerated significantly, and it is expected that the growth rate will be faster in the future, gradually occupying the mainstream of the market. However, in the high-end market, overseas manufacturers are still the main players.

2. The scope of statistics for discrete device solutions is mainly Impinj and domestic manufacturers. In 2023, there are several large projects in the domestic market that use UHF RFID discrete device readers in large quantities. However, the customized market is not stable, especially with more and more domestic cost-effective reader products. It is expected that the amount of discrete devices will decrease in the future.

3. Reader module and reader finished product manufacturers are mainly concentrated in China, but many companies have a large proportion of business from overseas markets.

3 Analysis of shipments of UHF RFID readers and writers by domestic and overseas manufacturers

19 Distribution of reader and writer products by domestic and overseas manufacturers (unit: 10,000)

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. This data is newly added in this year's version. In order to increase credibility, we start from the data statistics of 2021.

2. Domestic companies account for the absolute majority of manufacturers of reader-writer products, but the application customers of reader-writer hardware products are mainly overseas brands.

4 Market analysis of domestic manufacturers' UHF RFID reader products

UHF RFID readers come in various forms depending on the application scenarios, and the terminals presented vary greatly in the industry. Generally, readers are classified into fixed readers and mobile readers based on whether they are used in fixed or movable applications.

In this survey, based on market popularity, we selected several high-volume and high-price products from fixed readers for separate analysis, including printers, smart cabinets, and channel reader. The specific classification is as follows:

- Handheld devices (including other portable reader devices). The main form of this type of product is handheld devices, but there are also some tablets and wearable products that are applied to the market, which are classified into the same category.

- Printers are a common form of RFID fixed readers, mainly used for printing blank-label cards and Labels, and occasionally used for small-scale replacements due to Label wearout in logistics, finance, electricity, medical and other customized scenarios with relatively few Labels.

- Channel reader is a type of fixed reader mainly used for warehouse management and asset management.

- Smart cabinets are a recently emerged fixed reader product mainly used for asset management.

- Other fixed RFID reader devices: This category includes fixed RFID reader products that are not smart cabinets, printers, or channel readers, such as all in-one readers, card issuers, gateway readers, desktop readers, checkout devices, testing equipment, laboratory equipment, and so on.

- Discrete device-based readers: These are UHF RFID readers built using discrete components instead of standard chips. In some scenarios, these products can be customized based on user requirements. Recently, some large projects in the market have adopted this type of product, so it is analyzed separately in this report. Discrete device-based readers come in various forms, including fixed and mobile readers.

20 Domestic manufacturers' shipment distribution of UHF RFID readers of different forms (unit: 10,000)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Handheld devices (including tablets, wearables, etc.)	28	38	40	50	60	77	90	108
Printers	4	5	5	5	6	8	10	12
Smart cabinets/boxes	1	2	2	3	4	5	7	9
Access control/channel readers	3	4	5	6	7	9	10	11
Card issuers/gateways and other fixed readers	25	34	38	43	51	59	66	73
Discrete device reader products	5	5	17	12	9	7	7	7
Total	66	88	107	119	137	165	190	220

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

5 UHF RFID reader domestic user market & overseas user market analysis

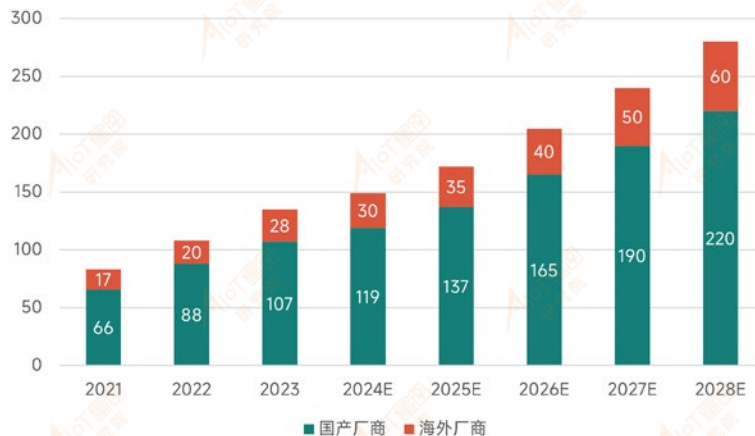**21 UHF RFID reader domestic user & overseas user analysis (unit: 10,000)**
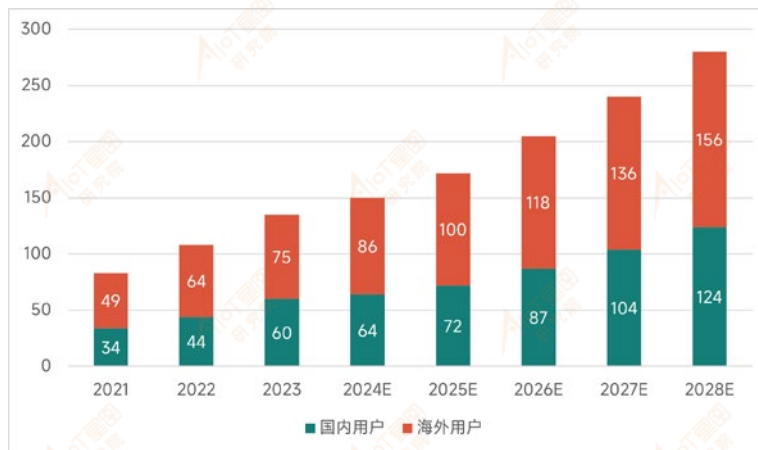
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. The scope of this data statistics is the number of UHF RFID readers worldwide, and then sort out the distribution of terminal users of these readers in China and abroad.

2. The shipment volume of domestic UHF RFID reader users is significantly higher than that of the Label market. The main reasons for this phenomenon are: First, most overseas markets are Label-type markets, mainly customers with a large number of Labels, and the proportion of readers required for this type of application scenario is relatively low; second, the "reader-writer market" accounts for a large proportion in the domestic market. The demand for customized market Labels is not large, but the proportion of readers is large. This data intuitively shows the difference between domestic and foreign application markets.

6 Analysis of segmented application scenarios of UHF RFID readers for domestic users in China

This white paper counts and predicts the shipment volume of UHF RFID readers in different segmented application markets in China, and the results are as follows:

22 Analysis of domestic user UHF RFID reading and writing product

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Retail	3	4	5	8	10	12	15	18
Books and archives	2	2	3	3	3	4	5	6
Express delivery	2	2	2	2	3	4	5	7
Industry	3	4	5	6	8	12	14	16
Electricity	4	5	5	5	5	5	6	7
Medical	2	2	3	4	5	6	6	7
Enterprise asset management	5	6	7	8	9	10	12	14
Urban public utilities	4	7	19	15	12	13	15	18
National/military standard market	3	5	3	3	3	4	5	6
Others	6	7	8	10	14	17	22	25
Total	34	44	60	64	72	87	104	124

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. Among domestic users, the demand for UHF RFID readers is evenly distributed. The relatively large demand scenarios include footwear and clothing retail, industrial production, enterprise asset management, urban public utilities, etc. Most of them belong to the reader-writer market.

2. If the express logistics industry can realize the application of single-item parcel labels, it will also require a large number of readers. Therefore, the express logistics industry has a large number of variables, and we will pay attention to and update it in a timely manner.

2.3.3 Market output value scale and forecast

In this year's white paper, we have made a more detailed analysis of the market output value, and the results are as follows:

1 Analysis of UHF RFID Inlay output value of domestic manufacturers and overseas manufacturer

23 Analysis of UHF RFID Inlay output value of domestic manufacturers and overseas manufacturers (unit: 100 million RMB)
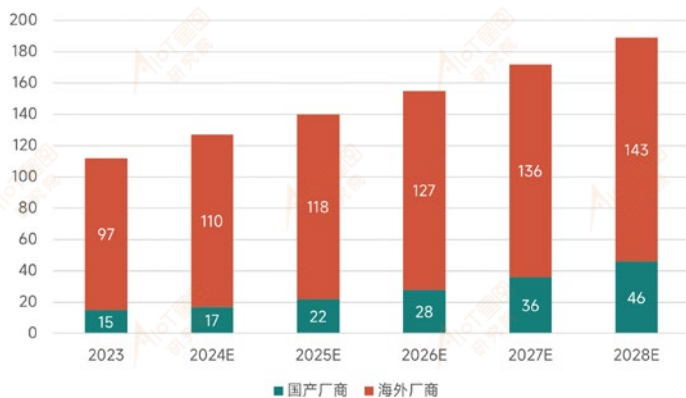
Data description:

1. Domestic manufacturers' data does not include Hong Kong, Macao and Taiwan-funded enterprises, and only the data of mainland Inlay manufacturers are counted.

2. The average unit price of Inlay of overseas manufacturers is higher than that of domestic manufacturers. With the expansion of scale, the unit price of products is on a downward trend.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2 Analysis of the output value of UHF RFID Labels by domestic and overseas manufacturers

24 Analysis of the output value of UHF RFID Labels by domestic and overseas manufacturers (unit: 100 million RMB)

国产通用标签 国产特种标签 海外标签厂商
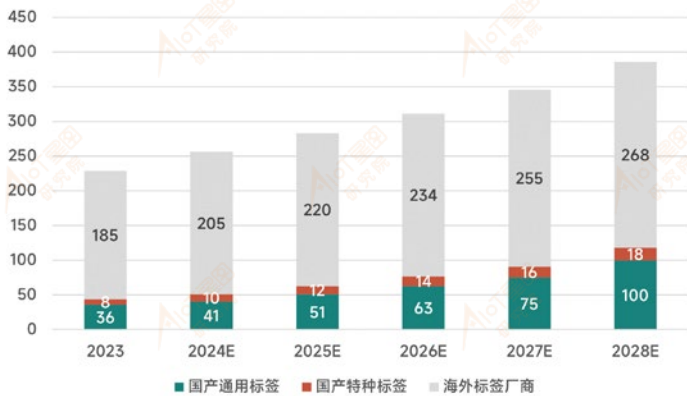
Data description:

1. The output value of labels takes into account special labels. Overall, in the general label market, the average unit price of domestic UHF RFID label products is still significantly lower than that of overseas label manufacturers, but the unit price of special labels is much higher than that of general label products.

2. The proportion of special labels of domestic manufacturers is significantly higher than that of overseas manufacturers, which has increased the output value of domestic UHF RFID labels.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3 Analysis of the output value of UHF RFID reader products of domestic and overseas manufacturer

25 Analysis of the output value of UHF RFID reader products of domestic and overseas manufacturers (Unit: 100 million RMB)

国产厂商 海外厂商
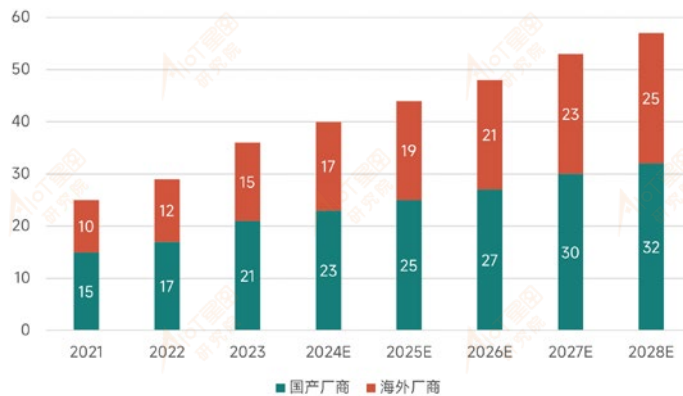
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. Compared with the shipment data, the output value of UHF RFID readers and writers of domestic and foreign companies is very different. Although the shipment volume of domestic UHF RFID readers and writers accounts for a much higher proportion than that of overseas companies, the average unit price of domestic UHF RFID readers and writers is much lower than that of overseas companies. Therefore, from the perspective of output value, the output value difference between the two is not so large.

2. The reasons for the low unit price of domestic UHF RFID readers and writers are: first, the proportion of domestic chips is relatively high, and the price of domestic chips is relatively low. In addition, the domestic reader and writer products are seriously involuted, so the proportion of reader and writer products at the hundred-yuan level is relatively large; second, domestic manufacturers still have a large proportion of discrete devices, and the price is also very low. In comparison, overseas discrete device readers and writers are relatively high-end products; third, even if they all use Impinj chips, the unit price of overseas manufacturers' products is much higher than that of domestic manufacturers.

4 Analysis of the market output value of UHF RFID hardware of domestic and overseas manufacturer

In the UHF RFID industry, our common Label products and reader products are hardware products, and in actual applications, there is also system value.

Therefore, based on the output value information of readers and Labels mentioned above, we have counted the output value of UHF RFID hardware products of domestic and overseas manufacturers, and the results are as follows:

26 Analysis of UHF RFID hardware output value of domestic and overseas manufacturers (unit: 100 million RMB)
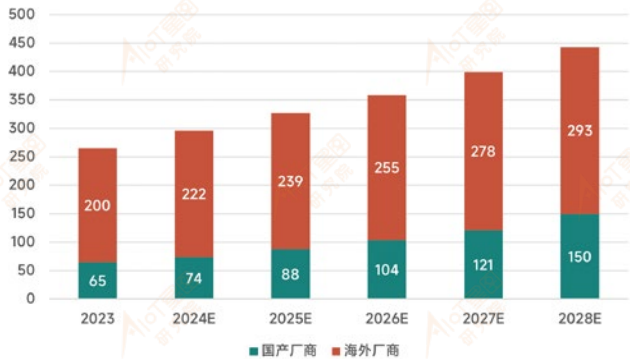
Data description:

1. The hardware output value statistics refer to the output value of UHF RFID finished Labels and reader products. Among the RFID companies we often see, most are hardware companies, so understanding the hardware output value is very helpful for understanding the entire industry.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

5 Analysis of the total output value of the UHF RFID market of Chinese domestic manufacturer

Based on the hardware data of domestic enterprises and supplemented with the system value of domestic end users, we evaluate the total output value of the domestic UHF RFID domestic industry chain as follows:

27 Total output value of UHF RFID market of domestic manufacturers (unit: 100 million RMB)
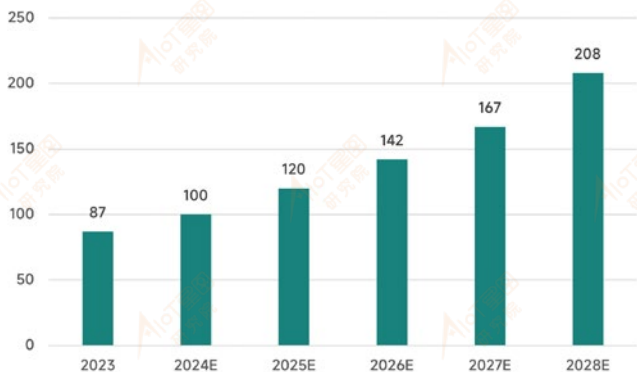
Data description:

1. This data statistics is the total market output value of domestic UHF RFID players and industrial chains, including hardware output value and system value of domestic end users.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

6 Analysis of the market output value of UHF RFID applications by domestic and overseas users

**28 Analysis of the market output value of UHF RFID applications by domestic and overseas users (Unit: 100 million RMB)**
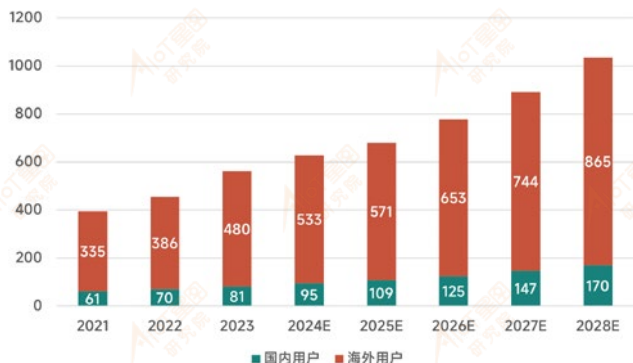
Data description:

1. The application output value comprehensively considers factors such as the value of hardware, the value of software, the value of system implementation, the value of data and services.

2. The domestic user market has a large proportion of industry users and government users, and the output value of a single Label is relatively high. The corresponding overseas market is mainly based on the general Label market.

3. In 2023, the global UHF RFID application market output value exceeded RMB 56 billion, which is about twice the hardware output value.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.4 UHF and HF dual-frequency RFID analysis

In this report, passive IoT RFID is divided into low frequency, high frequency, and ultra-high frequency bands. In fact, there are also some scenarios in the market using high frequency + ultra-high frequency dual-frequency RFID solutions. Therefore, in this chapter, we separately elaborate on the dual-frequency RFID market.

Dual-frequency RFID is a relatively special application market with a relatively simple industrial chain. In addition to integrating UHF + HF into the same IC, there are also some scenarios in the market that adopt a dual-Label solution combining UHF Labels with HF Labels.

In addition to the threshold for chips, the design and manufacturing of dual-frequency Labels are also more difficult than ordinary Labels because the working principles of HF and UHF in different frequency bands are completely different, one is near-field coupling, and the other is far-field radiation, requiring two different antenna combinations. Additionally, dual-frequency products are currently not widely used, so both chips and Labels for dual-frequency RFID are relatively expensive.

29 UHF & HF RFID Dual Frequency Label Chip Product Summary

Chip manufacture	Frequency band	Chip model	TID/UID area capacity (bit)	EPC area capacity (bit)	User area capacity (bit)	Sensitivity(dbm)	Product features	Applicable scenarios
Fudan Micro	High frequency &Ultra-high frequency dual-frequency	FM13DT 160			0~8K	Ultra-high frequency interface:Active temperature measurement,Read/write sensitivity:-24dBm	Measures temperature and supports dual-frequency	Cold chain logistics temperature monitoring,body temperature monitoring
Shanghai Quanray electronics	High frequency &Ultra-high frequency dual-frequency	Qstar-6S (S6S)	128	256	2K	Read:-19 Write:-11	Double frequency security anti-counterfeiting	Commodity anti-counterfeiting High-end commodity identification
		Qstar-6X (S6X)	128	256	2K	Read:-19 Write:-12	Physical anti-diversion, dynamic NDEF encryption	High-end product anti-counterfeiting
EM	High frequency &Ultra-high frequency dual-frequency	EM4425						Inventory and supply chain management,industry,automotive and aviation logistics,anti-Counterfeiting and traceability

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

2.4.1 Introduction to the advanLabeles of dual-frequency RFID

Dual-frequency RFID products have the following two advanLabeles:

AdvanLabele one: retain the function of UHF RFID's large-scale and fast inventory.

The biggest advanLabele of UHF RFID is its long transmission distance and group reading ability, which is very suitable for scenarios that require fast inventory, especially in B-side warehouse logistics, sorting links, and other applications.

AdvanLabele two: retain the ability of HF RFID to interact with mobile phones.

Because NFC on mobile phones is a type of HF RFID technology, HF RFID Labels can interact directly with mobile phones, greatly expanding the usage boundaries of RFID. In daily consumer goods, there is a demand for identifying the authenticity and anti-counterfeiting of relatively expensive items.

Therefore, dual-frequency RFID Label products can not only meet the needs of B-side for asset management and efficiency turnover, but also meet the needs of C-side people for anti-counterfeiting and traceability. It can form a good closed loop in business.

2.4.2 Introduction to the market and application of dual-frequency RFID

The application scenarios for using dual-frequency RFID products mainly have the following characteristics:

Firstly, the use scenarios require a combination of the high inventory efficiency of UHF RFID and the ability of HF RFID to interact with mobile phones. This requires a relatively large number of applications and a high concentration to meet the demand for large-scale inventory. Additionally, the products have strong consumer attributes and need to interact directly with consumers.

Secondly, the products in the application scenarios are relatively expensive, as the costlier items will stimulate consumers' demand for anti counterfeiting and traceability. Moreover, dual-frequency RFID Label products themselves are more expensive than single-frequency Labels, requiring high-value scenarios to justify such cost investments.

Thirdly, there is a strong demand for authenticity discrimination, but there is a lack of authoritative organizations to certify the products in the market. These products require consumers to distinguish between genuine and fake themselves, necessitating the use of technological means.

Based on this logic, we believe that the following areas are particularly suitable for using dual-frequency products:

1 High-end alcoholic products

This field is a scenario where dual-frequency RFID products are being used in large quantities. As high-end alcoholic products have an annual shipment volume of millions or even hundreds of millions of bottles, there is a demand for warehouse inventory. In addition, the selling price of high-end alcoholic products ranges from several hundred RMB to several thousand RMB, which can fully cover the cost of dual-frequency Labels. Consumers have a high demand for authenticity discrimination of these products.

2 Luxury goods

For example, high-end watches, handbags, and other products, which have high selling prices. Consumers have a strong demand for the authenticity of these products, and the market size is also large, requiring rapid inventory. Therefore, dual-frequency RFID Labels are widely used in this type of scenario. It is understood that many luxury brands are currently trying to use dual-frequency RFID Labels in foreign markets.

3 Collectibles

Collectibles include gold and jade artifacts, ancient artifacts and calligraphy works, as well as various crafts and other products. These products have high prices, but authenticity discrimination requires a high level of expertise, which is difficult for ordinary people to identify. Therefore, it is necessary to use dual-frequency RFID Labels for technical identification.

4 Libraries

Currently, some libraries in China use dual-frequency solutions. However, this is a problem left over from industry development. In the early days, many libraries used high-frequency Labels, but with the maturity of UHF RFID and cost reduction, UHF can also meet market demand. This has led to many libraries that use high-frequency solutions to adopt dual-frequency solutions for transition.

2.5 Summary of the Latest Trends of China's UHF RFID Passive Internet of Things Industry

Trend 1: The market recognition of domestic UHF RFID chips is increasing

Whether it is UHF RFID Label chips or reader chips, the market recognition of domestic products is gradually increasing. Domestic chips have been widely used in domestic terminal users, and are currently being introduced into some large overseas projects. With the iteration of products, the performance gap between domestic and foreign chips is gradually narrowing.

Trend 2: More and more powerful giant players are actively deploying RFID passive Internet of Things

In recent years, the RFID passive Internet of Things industry is breaking the circle and absorbing the layout of some giant companies. For example, Huawei and China Mobile, giants in the communications industry, are actively deploying passive Internet of Things, and logistics giants such as JD.com, Cainiao, SF Express, and China Post have already made in-depth layouts.

Trend 3: RFID passive IoT will be integrated into cellular communication networks

In the previous version, we also introduced 5G cellular passive IoT. Last year, the news was not yet finalized, but this year, we saw that 5G cellular passive IoT will become a 3GPP standard. This is more certain. It is expected that the standard will be frozen in the second half of 2025. Once it is finalized, the passive IoT industry will be integrated into the cellular communication network, which will bring huge market potential and is also a big boon to the UHF RFID industry.

Trend 4: The leading label factories are still expanding their production capacity, while the expansion rate of small and medium-sized label factories is slowing down

In the past year, we have seen that the leading inlay factories at home and abroad are actively expanding their production capacity, but the expansion rate of small and medium-sized inlay factories is slowing down. This phenomenon also shows that the concentration of the market is increasing, and the market share of the leading large factories is further increasing under the drive of large projects.

Trend 5: The speed of RFID popularization in the domestic footwear and clothing market is increasing

In the past one or two years, we have seen that the progress of RFID Labels on domestic footwear and clothing brands is significantly accelerating. Leading brands such as Anta and Bosideng are fully equipped with RFID Labels, and among the top 100 domestic footwear and clothing brands, at least half of the companies are actively embracing RFID. Perhaps in a few years, we will see RFID Labels become the standard in the footwear and clothing industry.

Trend 6: There are more and more single projects with large demand for readers and writers in the domestic market

The demand for readers and writers in the domestic market is relatively large, mainly because there are more and more single large projects in the market. Typical scenarios include industrial production lines, large footwear and clothing retail brands, electricity, urban public utilities, etc., in which there are single projects with tens of thousands of readers and writers.

Trend 7: RFID Labels are further penetrating the domestic express logistics industry, but it is not time for RFID to be used on single-item packages

RFID Labels have been widely used in transit bags in the domestic express logistics industry. In this year's survey, we saw that RFID Labels are popular in JD's large warehouses and Cainiao's overseas orders.

However, there is no relevant information on using RFID Labels on every express package.

Trend 8: Pure price-competition is not desirable, and companies are finding their own way to survive

As long as there is a business that makes money, there will be internal competition. This year, the industry's internal competition is still serious. If it is just price-competition, it is not desirable. Many companies will often cause projects to fail after they do not make money. In the business environment where profits are gradually thinning, companies are looking for their own ways to survive, such as doing customized markets; making differentiated products and services; using scale advanLabeles to reduce supply chain costs, etc.

Trend 9: Environmentally friendly RFID Labels are gradually maturing and gaining attention

RFID Labels are a consumable material that has been popularized in footwear and clothing retail scenarios. Compared with traditional paper Labels, RFID Labels currently have more or less pollution. Driven by the concept of environmental protection and sustainable development, many companies in the industry have been moving towards how to make RFID Labels more environmentally friendly.

First, the antenna production process. The traditional etching process has a lot of chemical pollution, while processes such as die-cutting and printing reduce the pollution caused by the antenna production process;

Second, the material selection of the antenna itself. Whether it is aluminum or copper, the final label has a certain amount of pollution. There are also companies in the market that are studying some special antenna formulas. On the basis of ensuring the electrical performance of the antenna, the proportion of metal content can be reduced to achieve the purpose of degradation; Finally, it is the replacement of difficult-to-degrade materials such as PET. The etching process requires plastics such as PET as the substrate, while the printing process on the market can use ordinary paper materials as the substrate, so that it can be naturally degraded.

According to our research, more and more large companies will give priority to environmentally friendly factors when choosing technology. Under such market drive, the proportion of environmentally friendly RFID Labels in the industry will gradually increase.

Trend 10: The specialty Label market is constantly innovating and unlocking more new applications.

General RFID Label products are highly homogenized, and the main competition is price and supply chain. However, in this year's survey, we have seen that the domestic specialty RFID Label market is constantly innovating, such as high temperature resistance, corrosion resistance, RFID+ sensors, etc., to make RFID Labels more and more application scenarios.

Part 3
China HF RFID Passive Internet of Things Industry Report

3.1 Analysis of China's HF RFID Passive IoT Industry Chain

The typical operating frequency of HF (high frequency) RFID Labels is 13.56MHz. When the Label exchanges data with the reader, the Label must be located in the near field of the reader antenna radiation. High frequency Labels are widely used in electronic tickets, electronic ID cards, bank cards, community property management, building access control systems and other fields. At present, most HF RFID products are compatible with the NFC protocol, so it is difficult to distinguish between NFC and HF RFID in the market. This white paper incorporates NFC into the HF RFID industry. Because of the NFC function, most HF RFID Label products on the market can interact directly with mobile phones, which greatly expands the scope of use of HF RFID.

HF RFID industry chain
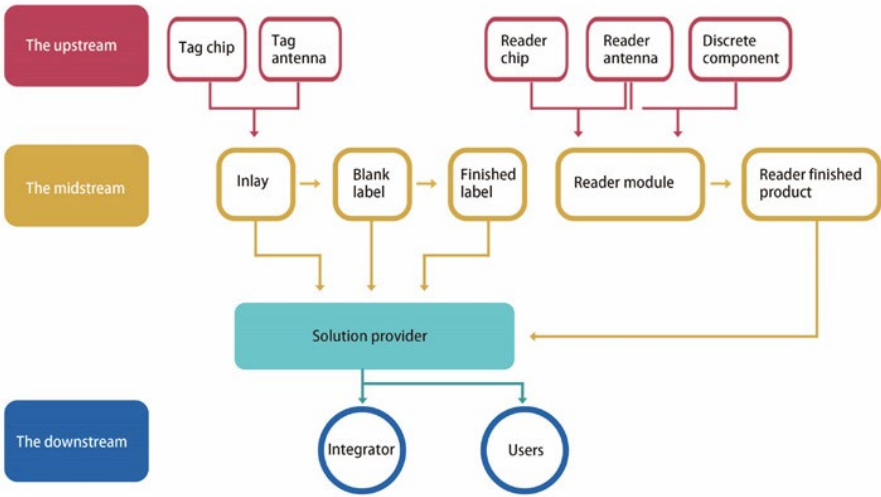
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3.1.1 Upstream of the Industry Chain

The upstream links of HF RFID are mainly chips and antennas. Chips are divided into Label chips and reader-writer chip products. For specific players of high-frequency chips, please refer to the "IOTE·China RFID Passive Internet of Things Industry Atlas (2024 Edition)" in this white paper. The HF reader-writer market can be divided into two categories, one is standard IC products; the other is discrete devices. HF RFID discrete readers are very common.

The working principle of high-frequency RFID is similar to that of low-frequency RFID. Its antenna is in the form of a coil. Because the frequency of HF is much higher than that of LF, the number of turns of its antenna coil is much less. Therefore, in addition to the traditional copper wire winding, the antenna of high-frequency RFID can also be made by etching. This allows the form of high-frequency RFID Labels to be smaller, thinner, and more flexible, and the scope of application is also greatly expanded.

30 Summary of major HF RFID Label chip manufacturers and product features

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Kiloway	KX1010P-B	Compliant with ISO/IEC15693 protocol, NFC Forum T5T; Large capacity, dense group reading, high cost performance Compatible with I-CODE2 function (supports TI reader/writer writing)	64	1728		New retail, smart disk, traceability management, etc.
	KX1010P-BK	Compliant with ISO/IEC15693 protocol, NFC Forum T5T; Large capacity, dense group reading, secure encryption, extremely cost-effective Compatible with I-CODE2 function (supports TI reader/writer writing)	64	1728		Valuables management, anti-counterfeiting traceability, etc.
	KX1010P-BKR	Compliant with ISO/IEC15693 protocol, NFC Forum T5T; Large capacity, dense group reading, secure encryption, anti-medical radiation Compatible with I-CODE2 function (supports TI reader writing)	64	1728		Medical/medical goods management, etc.
	KX1207-B	Compliant with ISO/IEC14443 TypeA protocol, NFC Forum T2T; Large capacity, high cost performance	56	1888		NFC applications, brand promotion, etc.
	KX1207-BK	Compliant with ISO/IEC14443 TypeA protocol, NFC Forum T2T; Large capacity, secure encryption, and extremely cost-effective	56	1888		Valuables management, anti-counterfeiting traceability, etc.
	KX1207-BKR	Compliant with ISO/IEC14443 TypeA protocol, NFC Forum T2T; Large capacity, secure encryption, and resistant to medical radiation	56	1888		Medicine/medical supplies management, etc.
	KX1001-AR	Compliant with ISO/IEC15693 protocol; Ultra-large capacity, resistant to harsh environments such as medical radiation Compatible with Label-IT	64	7680		Asset management, medicine management, solar panels, etc.
Fudan Microelectronics	FM13Series(FM13HF02,FM13HS02,FM13HF01,FM13HS01)	Contactless interface:NFC FORUM Type5 Label,ISO 15693		1000/2000	Maximum transmission speed: 53kbps	Book management, catering, smart manufacturing, anti-counterfeiting and traceability, important materials management, conference certificates
	FM11NT021TT	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		144	Data transmission rate: 106 Kbit/s	Item identification, smart packaging
	FM11NT021	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		144	Data transmission rate: 106 Kbit/s	Item identification, consumables management, game entertainment, smart speakers
	FM11NT041	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		504	Data transmission rate: 106 Kbit/s	Scenario definition and connection initiation, game dolls
	FM11NT081	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		888	Data transmission rate: 106 Kbit/s	Online payment portal, digital currency
	FM11NT022	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		144	Data transfer rate: 106 Kbit/s	Item identification, gaming and entertainment
	FM11NS022	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		240	Contactless maximum transmission rate: 106 kbit/S	Consumables management, offline authentication, lightweight security applications

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Fudan Microelectronics	FM11NT032		Contactless interface: ISO14443 TypeA, NFC FORUM Type2 Tag		256	Data transmission rate: 106Kbit/s
	FM11NT081D	Contact interface:I²C,SPI Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		888	Data transfer rate: 106 kbit/s 12C maximum communication rate: 1M bps SPI maximum communication rate: 5M bps	Electronic shelf labels, WIFI network configuration for smart appliances, Bluetooth pairing
	FM11NC08	Contact interface:I²C,SPI Contactless interface:ISO14443 TypeA		8k	Contactless data transmission rate: 106, 212, 424, 848Kbps I2C maximum communication rate: 1M bps SPI maximum communication rate: 10M bps	Electronic shelf labels, smart routers, keyboards, speakers
	FM11NT082C	Contact interface:I²C Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		888	Data transfer rate: 106 Kbps 12C maximum data transfer rate: 1M bps	Electronic shelf labels, electrical product traceability management, one-touch connection, one-touch transmission
	FM11NP04	Contact interface:I2C Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		560	Data transfer rate: 106 Kbps 12C maximum data transfer rate: 1M bps	LED lamps, smart routers
	FM11NL08	Contactless interface:ISO14443 TypeA,NFC FORUM Type2 Tag		888		Passive locks
Shanghai Quanray Electronics	QMars-5X (M5X)	ISO/IEC14443 Type A,NFC Forum Type 2 protocol	64 Optional	1K	106Kbit/s	Anti-counterfeiting verification, electronic business cards, NFC shelf labels
	QMars-6X (M6X)	ISO/IEC 15693 protocol	64 Optional	256/896/2528	53kbits/s	Unmanned retail, libraries, anti-counterfeiting, etc.
	QMars-5U	ISO/IEC 15693		256	53kbits/s	Unmanned retail, consumer product anti-counterfeiting, library labels, industrial fields
Feiju Microelectronics	F8001Z/F8001X	ISO/IEC 14443A		752	Communication rate: 106Kbit/s	Wallets, smart cards
	F8004	NFC Type2; ISO/IEC 14443A		48	Communication rate: 106Kbit/s	One-way tickets, public transportation ticketing systems and NFC (near field communication), etc.
	F8003	ISO/IEC 14443A		3568	Communication rate: 106Kbit/s	Smart cards
	F8213	NFC Type2; ISO/IEC 14443A		144	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, quick pairing, etc.

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Feiju Microelectronics	F8216CF	NFC Type2; ISO/IEC 14443A		944	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, etc.
	F8216F	NFC Type2; ISO/IEC 14443A		888	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, etc.
	F8216	NFC Type2; ISO/IEC 14443A		888	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, etc.
	F8215	NFC Type2; ISO/IEC 14443A		504	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, etc.
	F8025	NFC Type5; ISO/IEC 15693		128	Communication rate: 53Kbps	Airline parcel and baggage identification, mail sorting, commodity circulation control and electronic anti-theft
	F8025SF	NFC Type5; ISO/IEC 15693		128	Communication rate: 53Kbps	Airline parcel and baggage identification, mail sorting, commodity flow control and electronic anti-theft
	F8018	NFC Type2; ISO/IEC 14443A		144	Communication rate: 106Kbps	Near field communication
	F8013	NFC Type2; ISO/IEC 14443A		144	Communication rate: 106Kbps	Bluetooth pairing, WIFI connection establishment, mutual authentication of device time, NFC mobile phone standard label, smart poster, commodity detection, shelf label.
	F8019	NFC Type5; ISO/IEC 15693		256	Communication rate: 53Kbps	Air parcel and luggage identification, mail sorting, commodity circulation control and electronic anti-theft.
	F8023	I²C NFC Type5; ISO/IEC 15693		144	Communication rate: 53Kbps	Air parcel and luggage identification, mail sorting, commodity circulation control and electronic anti-theft.
	F8022	I²C NFC Type5; ISO/IEC 14443A		1912	Communication rate: 106Kbps	Smart home, consumer electronics, smart instrument, smart medical
	F8216C	NFC Type2; ISO/IEC 14443A		944	Communication rate: 106Kbps	Smart posters, product detection, business card applications, shelf labels, quick pairing.
	F8216SC	NFC Type2; ISO/IEC 14443A		996	Communication rate: 106Kbps	Product anti-counterfeiting, identity authentication.
	F8213SC	NFC Type2; ISO/IEC 14443A		144	Communication rate: 106Kbps	Product detection, product anti-counterfeiting, identity authentication.
	F8010	NFC Type2; ISO/IEC 14443A		144	Communication rate: 106Kbps	Systems with high security requirements and NFC (near field communication).
	F8002-1024	NFC Type5; ISO/IEC 15693		128	Communication rate: 53Kbps	Air parcels, baggage identification, mail sorting, product circulation control, electronic anti-theft

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Feiju Microelectronics	F8002-2048	NFC Type5; ISO/IEC 15693		256	Communication rate: 53Kbps	Air parcel and baggage identification, mail sorting, product circulation control and electronic anti-theft
	F8002P-2048	NFC Type5; ISO/IEC 15693		256	Communication rate: 53Kbps	Air parcel and baggage identification, mail sorting, product circulation control and electronic anti-theft
Shandong Huayi Micro Electronics Technology	HYm4616A Series(A1/A2/A3/A4/A5/A6A7)	ISO/IEC 14443 TYPEA	4byte(Factory configuration)	2k/4k/8k /16k/32k /40k/80k bytes	106 Kbps	Small amount payment, city card, campus card, high-end access control, membership card, residence permit/finance IC card 1 financial social security card/finance E T C, etc.
	HYM4616B Series(B4/B5/B6/B7)	ISO/IEC 7816	4byte(Factory configuration)	16k/32k/40k /80k bytes	9600/115200/38400 bps	Financial IC card, financial social security card, financial ETC, residence permit, small payment, city card, public transportation, identity recognition, etc.
	HYm4616C Series(C4/C5/C6/C7)	ISO/IEC 14443 TYPEA ISO/IEC 7816	4byte(Factory configuration)	16k/32k/40k /80k bytes	Contactless interface:106 Kbps Contact interface: 9600/115200/38400 bps	Financial IC card, financial social security card, financial ETC, residence permit, small payment, city card, public transportation, identity recognition, etc.
	HY5950/HY5960	ISO 18000-3 mode 3 /EPC Class-1	96 bit	512 bit	Downlink rate: 25Kbps~100 Kbps Uplink rate: 53Kbps~848 Kbps	Document and archive management, book and examination paper management Financial bill management, drawing and picture book management Medical inspection management, jewelry chip management Anti-counterfeiting traceability management, electronic ticket management
Huada Evercore	CIT83128Series (including CIT3128/CIT3128A/CIT3128B)	Complies with ISO/IEC 15693 protocol standards Complies with SB/T 10768-2012 Technical requirements for bottled wine traceability and anti-counterfeiting labels based on radio frequency identification	64	320/672	Downlink data rate: Reader to chip: 26.48/1.66Kbps Uplink data rate: 26.48/6.62Kbps 26.69/6.67Kbps	Anti-counterfeiting traceability, retail, access control, books, etc.
	CIT83512Series (including CIT83512A, CIT83512A-T, CIT83512B, CIT83512B-T)	Complies with the "ISO/IEC15693" protocol standard Complies with the NFC-V protocol Complies with the "Technical requirements for bottled wine traceability and anti-counterfeiting labels based on radio frequency identification"	64	3520	Downlink data rate: 26.48/1.66Kbps Uplink data rate: 5316.62Kbps 26.69/6.67Kbps	Anti-counterfeiting traceability, asset management
Giantec Semiconductor	GT23SC4439 Series(39C/39D)	ISO/IEC14443A		1 KB	106 Kbps	
	GT23SC4469	ISO/IEC14443A		4 KB	106 Kbps	
	GT23SC445 Series (4455/4456/4458)	ISO/IEC14443A		4K/8K/16K	106 Kbps	

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Giantec Semiconductor	GT23SC4466	ISO/IEC 7816,ISO/IEC14443A/B I²C interface		64K		
	GT23SC8899 Series (88991/ 8899B-1/8899-2/ 8899B2/8899-3/ 8899B-3/8899-4)	NFC Forum Type2 Tag		180/540 /924/1940	106 Kbps	
	GT23SC8899C Series (C-1/C-3/C-4)	NFC Forum Type2 Tag,Support field strength detection		180/924/1940	106 Kbps	
	GT23SC6699 Series (6699-1/6699-2)	NFC Forum Type2 Tag,I²C interface		1024/2048	106 Kbps	
	GT23SC4419 Series (4419-1/4419-2/4419-3)	NFC Forum Type5 Tag ,ISO/IEC 15693		1024	53 kbit/s	
	GT23SC4479	ISO/IEC14443A		64	106 Kbps	
	GT23SC4489	NFC Forum Type2 Tag,Support DES encryption algorithm		192	106 Kbps	
Zhuojie Chuangxin Technology	EL9313	ISO 18092 NFC-1 / 21481 NFC-2		1440	106kbps	Animal identification, livestock and pet management, blood bag management, etc.
	EL8318	ISO14443-A International smart card standards		8K	106k	Access control, asset management, key rings, etc.
ST	ST25TA Series	ISO14443-A RF/NFC forum type 4		512bit to 64Kbit		Consumer electronics, computer peripherals, gaming equipment, home appliances, industrial automation and medical products
	ST25TB Series	ISO14443-2 Class B with proprietary protocol		512bit,2K,4K		Public transportation and event ticketing
	ST25TN Series	ISO/IEC 14443 Type A,NFC Forum Type 2		1.6kbit	106 kb/s	Games, apparel and footwear, consumer packaged goods, sports industry, alcohol, etc.
	ST25TV Series	ISO/IEC 15693 & NFC Forum Type 5		2kbit	53 kb/s	Medical and health, consumer packaged goods, luxury goods, wine and spirits, pharmaceuticals
	ST25DV-I2C Series	ISO 15693/NFC Forum Type 5		64 Kb	53 kb/s	Network configuration, parameter setting, firmware upgrade, Bluetooth/Wi-Fi pairing, consumer interaction, etc.
	ST25DV-PWM Series	ISO 15693/NFC Forum Type 5		2 Kb	53 kb/s	LED driver programming, parameter setting, product information, asset tracking
	M24SR Series	ISO 14443-A/NFC Forum Type 4		64 Kb	106 kb/s	Parameter setting, Bluetooth/Wi-Fi pairing, consumer interaction, data logging, asset tracking
	M24LR Series	ISO 15693/NFC compliant		64 Kb	53 kb/s	Parameter setting, Bluetooth/Wi-Fi pairing, consumer interaction, data logging, LED driver programming

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
NXP	NLabel 424 DNA label tampering detection	ISO/IEC 14443A 1-4, NFC Forum T4T		416 (including 128B security data file)		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 424 DNA	ISO/IEC 14443A 1-4, NFC Forum T4T		416 (including 128B security data file)		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 426Q DNA	ISO/IEC 14443A 1-4, NFC Forum T4T		916 (including 128B security data file)		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 223/224 DNA	ISO/IEC 14443A 1-3, NFC Forum T2T		144 / 208		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 223/224 DNA StatusDetect	ISO/IEC 14443A 1-3, NFC Forum T2T		144 / 208		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 213 Label Tamper Detection	ISO/IEC 14443A 1-3, NFC Forum T2T		144		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 213/215/216	ISO/IEC 14443A 1-3, NFC Forum T2T		144 / 504 / 888		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 210/212	ISO/IEC 14443A 1-3, NFC Forum T2T		48 / 128		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NTAG 210μ (Micro)	ISO/IEC 14443A 1-3, NFC Forum T2T		48		Brand protection and anti-counterfeiting, anti-tampering and completion fraud protection
	NHS3100	NFC/RFID ISO 14443 Type A interface 12C bus interface				Temperature sensor and direct battery connection
	NHS3100UK	NFC/RFID ISO 14443 Type A interface 12C bus interface				Temperature sensor and direct battery connection
	NHS3100W8	NFC/RFID ISO 14443 Type A interface 12C bus interface				Temperature sensor and direct battery connection
	NHS3152	NFC/RFID ISO 14443 Type A interface 12C bus interface				Temperature sensor, ADC, DAC, current sensor and direct battery connection
	NHS3152UK	NFC/RFID ISO 14443 Type A interface 12C bus interface				Temperature sensor, ADC, DAC, current sensor and direct battery connection
	ICODE 3 and ICODE3 Labels are tamper-proof	ISO 18000-3M1 NFC Forum T5T		2400		Product identification, tracking and traceability, asset and inventory management, etc.
	ICODE DNA	ISO 18000-3M1 NFC Forum T5T		2016		Product identification, tracking and traceability, asset and inventory management, etc.

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
NXP	ICODE SLIX 2	ISO 18000-3M1 NFC Forum T5T		2528		Product identification, tracking and traceability, asset and inventory management, etc.
	ICODE SLIX	ISO 18000-3M1 NFC Forum T5T		896		Product identification, tracking and traceability, asset and inventory management, etc.
	ICODE SLIX-L	ISO 18000-3M1 NFC Forum T5T		256		Product identification, tracking and traceability, asset and inventory management, etc.
	ICODE SLIX-S	ISO 18000-3M1 NFC Forum T5T		1280		Product identification, tracking and traceability, asset and inventory management, etc.
	ICODE ILT-M	EPC Class-1 HF1		512		Product identification, tracking and traceability, asset and inventory management, etc.
	MIFARE DESFire EV3	ISO/IEC 14443 A 1-4 & ISO/IEC 7816				Public transportation, hotels, points and micropayments
	MIFARE DESFire Light	ISO/IEC 14443 A 1-4 & ISO/IEC 7816				Public transportation, hotels, points and micropayments
	MIFARE Ultralight AES	ISO/IEC 14443 A 1-3				Public transportation, hotels, points and micropayments
	MIFARE Ultralight C	ISO/IEC 14443 A 1-3				Public transportation, hotels, points and micropayments
	"MIFARE Ultralight EV 1"	ISO/IEC 14443 A 1-3				Public transportation, hotels, points and micropayments
	MIFARE Plus EV2	ISO/IEC 14443 A1-4 and ISO 7816-4				Public transportation, hotels, points and micropayments
	MIFARE Classic EV1	14443-3 Type A				Public transportation, hotels, points and micropayments
EM	EM4033	ISO15693 / ISO18000-3	64			Laundry, library and archives, asset management, etc.
	EM4237SLIC/SLIX	ISO/IEC15693 and ISO/IEC18000-3		1024 bits/2048		Book archives, laundry, gambling, ticketing, etc.
	EM4233SLIC	ISO15693 / ISO18000-3	64	1k		Book archives, asset management, medicine, etc.
	EM4332	NFC Forum Type 2 protocol, ISO 14443-A		308	106kbps	Product traceability, membership cards, etc.
	EM4233	ISO15693 / ISO18000-3	64	2k		Book archives, access control, asset management
	EM4237	ISO/IEC 15693 and ISO/IEC18000-3		2k		Medicines, valuables, tickets, etc.
	EM4333	ISO/IEC15693/14443A		4k		Access control, public transportation, anti-counterfeiting, etc.

Chip manufacturers	Chip model	Supporting protocolsl standards	Supporting protocolsl standards TID/UID area capacity(bit)	EPC area capacity(bit)	Transfer rate(Kbps)	Applicable scenarios
Silicon Craft	SIC4310/11	NFC-Forum type 2 Tag				NFC sound and LED energy harvester, battery-free ink screen"
	SIC43NT	NFC Tag Type 2				Product anti-counterfeiting application, delivery proof/ voucher authentication, online game electronic card
	SIC43S1	NFC-Forum Type 2				Interactive/mutual authentication, encrypted communication
	SIC4340	NFC-Forum type 2 /ISO14443A				Smart toys Temperature sensors Pressure sensors
	SIC4341	NFC-Forum type 2 /ISO14443A				Blood glucose sensor Chemical sensor Corrosion test

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

AIoT星图 研究院

31 Summary of major HF RFID reader chip manufacturers and product features

Chip manufacturers	Chip model	Supporting protocolsl standards	Reader operating distance	Transfer rate	Applicable scenarios
Fudan Microelectronics	FM17580	Control interface:SPIContactless interface:ISO14443 A/B	5cm	Type A supports communication rates: 106kbps, 212kbps, 424kbps SPI maximum rate: 10Mbps	Door locks, E-bikes, anti-counterfeiting, meters, etc.
	FM17550	Control interface:SPI,UART,12C Contactless interface:ISO14443 A/B	5cm	Type A supports communication rates: 106kbps, 212kbps, 424kbps SPI maximum rate: 10Mbps	POS, door locks, E-bikes, anti-counterfeiting, etc.
	FM17610	Control interface:SPIContactless interface:ISO14443 A/B		Type A supports communication rates: 106kbps, 212kbps, 424kbps SPI maximum rate: 10Mbps	Door locks, E-bikes, anti-counterfeiting, meters, etc.
	FM17622	Control interface:SPI,UART,12C Contactless interface:ISO14443 A/B	5cm	Type A supports communication rates: 106kbps, 212kbps, 424kbps SPI maximum rate: 10Mbps 12C maximum rate: 3.4Mbps	Door locks, meters, etc.
	FM17660	Control interface:SPI,UART,12C Contactless interface:ISO14443 A/B			POS, door locks, etc.
	FM17660A	Control interface:SPI,UART,12C Contactless interface:ISO14443 A/B			Digital keys, car aromatherapy, etc.
Feiju Microelectronics	TSC9822	ISO/IEC 14443A	5cm	ISO14443 TYPEA supports communication rates of 106kbps, 212kbps, 424kbps, 848kbps	
	TSC9823	ISO/IEC 14443A; ISO/IEC14443B	5cm	ISO14443 TYPEA supports communication rates of 106kbps, 212kbps, 424kbps, 848kbps	
	TSC9820	ISO/IEC 14443A	5cm	ISO14443 TYPEA supports communication rates of 106kbps, 212kbps, 424kbps, 848kbps	
	TSC9605	ISO/IEC 14443A	10cm	Support contactless high-speed communication mode, baud rate up to 424kb/s	
	TSC9601	ISO/IEC 14443A; ISO/IEC14443B	10cm	Support contactless high-speed communication mode, baud rate up to 424kb/s	

Chip manufacturers	Chip model	Supporting protocolsl standards	Reader operating distance	Transfer rate	Applicable scenarios
Feiju Microelectronics	TSC9622	ISO/IEC 14443A; ISO/IEC14443B; ISO/IEC 15693	10cm	Support contactless high-speed communication mode, baud rate up to 424kb/s	
	TSC9812	ISO/IEC 14443A; ISO/IEC14443B	The typical operating distance in reader/writer mode is more than 5 cm. The operating distance in NFCIP-1 mode is up to 5 cm. The typical operating distance in card operation mode is about 10 cm.	Supports ISO 14443A higher transmission rate communication: 212kbit/s and 424kbit/s	
	TSC9883	ISO/IEC 14443A; ISO/IEC14443B; ISO/IEC 15693	5cm	Transmission speed up to 848 kbit/s	
Huada Evercor	CII83A	Support ISO/IEC15693 protocol			
Shandong Huayi Microelectronics Technolog	HY9840	ISO/IEC14443 TypeA&B 15693		Supports SPI interface communication with a maximum read and write rate of 2MHz	Supply chain and logistics management, library and document management, supermarket automatic settlement and anti-theft, drug and food traceability, game hall chips, city card, public transportation, identity recognition, citizen card
Nanjing Chinese Science and Technology University	Si522A	ISO/IEC 14443 A/MIFARE	5cm		Smart payment, smart door
	Si523	ISO/IEC 14443 A/B/MIFARE	5cm		Smart payment, smart door
	Si512	ISO/IEC 14443 A/B/MIFARE and Felica	5cm		Smart payment, smart door
	Ci522	ISO/IEC 14443 A/MIFARE	5cm		Smart payment, smart door lock, instrument unlocking
	Ci523	ISO/IEC 14443 A/B/MIFARE	5cm		Smart payment, smart door lock, instrument unlocking
	Ci520	ISO/IEC 14443 A/MIFARE	5cm		NFC card swiping control, smart door lock
	Ci521	ISO/IEC 14443 A/B/MIFARE	5cm		NFC card swiping control, smart door lock
	Si522	ISO/IEC 14443 A/MIFARE	5cm		Smart payment, smart door
Giantec Semiconductor	GT23SC55460/ GT23SC55460A	ISO/IEC14443A		106 Kbps	
ST	ST25R95	SO14443A,B/ ISO15693		424 kbps SPI 2Mbps	Access control, games, meters
	ST25R3911B	ISO14443A,B/ ISO15693/ FeliCa			Point of sale terminals, passport reading terminals, industrial terminals
	ST25R3912	ISO4443A,B/ ISO15693/ FeliCa			Point of sale, access control
	ST25R3914/15	ISO14443A,B/ ISO15693/ FeliCa			Automobile
	ST25R3916	ISO14443A,B/ ISO15693/Felica			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R3916B	ISO14443A,B/ ISO15693/Felica			Sales terminals, industrial terminals, consumer terminals, access control

Chip manufacturers	Chip model	Supporting protocolsl standards	Reader operating distance	Transfer rate	Applicable scenarios
ST	ST25R3917	ISO14443A,B/ ISO15693/Felica			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R3917B	ISO14443A,B/ ISO15693/Felica			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R3918	ISO14443A/B ISO15693/Felica			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R3919B	ISO14443A/B ISO15693			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R3920	ISO14443A,B/ ISO15693/Felica			Car, CCC digital key, door lock, center console
	ST25R3920B	ISO14443A,B/ ISO15693/Felica			Car, CCC digital key, door lock, center console
	ST95HF	ISO14443A,B/ ISO15693/Felica			Access control, games, meters
	CR95HF	ISO14443A,B/ ISO15693/Felica			Access control, games, meters
	ST25R100	ISO14443A/B ISO15693			Sales terminals, industrial terminals, consumer terminals, access control
	ST25R200	ISO14443A/B ISO15693			Sales terminals, industrial terminals, consumer terminals, access control
NXP	MIFARE SAM AV3	DNA range of MIFARE ICs and NTAG, ICODE and UCODE product families			Card readers and POS terminals, toll gates and door locks
	PN7642	ISO/IEC14443A-B, FeliCa TM,ISO15693, ISO18000 EPC-HF, etc.			Industrial control, NFC applications, access control
	PN7462 Series	ISO/IEC 14443A/B, FeliCa,ISO/IEC 15693, ISO/IEC 18000-3M3,NFC Forum type1,2,3,4,5			Industrial control, NFC applications, access control
	PN7160	ISO/IEC 14443A/B, FeliCa,ISO/IEC 15693, NFC Forum type1,2,3,4,5			Fitness, healthcare, white goods, etc.
	PN5190	ISO/IEC 14443A/B, FeliCa,ISO/IEC 15693, ISO/IEC 18000-3M3,NFC Forum type1,2,3,4,5			POS terminals, citizen ID cards, access control management
	PN5180	ISO/IEC 14443A/B, FeliCa,ISO/IEC 15693, ISO/IEC 18000-3M3,NFC Forum type1,2,3,4,5		848 kBit/s	Industrial card readers, payment terminals, access control
	CLRC663+Series	ISO/IEC 14443A/B, FeliCa,ISO/IEC 15693, ISO/IEC 18000-3M3,NFC Forum type1,2,3,4,5			Industrial card readers, payment terminals, access control
EM	EM4094	ISO15693 and ISO14443			Handheld readers, low-cost readers

Chip manufacturers	Chip model	Supporting protocolsl standards	Reader operating distance	Transfer rate	Applicable scenarios
Silicon Craft	RA10	ISO14443A/SPI interface			Access control, automobile (access), industrial management, public transportation, payment systems, etc.
	RA12				Access control, automobile (access), industrial management, public transportation, payment systems, etc.
	RE31	ISO14443A/B, ISO15693 /SPI interface			Access control, automobile (access), industrial management, public transportation, payment systems, etc.
	RE41	ISO14443A-B/15693 JIS X6319-4 Protocol Felica UnionPay PPOC1.0			Access control, automobile (access), industrial management, public transportation, payment systems, etc.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3.1.2 Midstream of the Industrial Chain

The midstream of high-frequency RFID mainly covers high-frequency tag and high-frequency card suppliers, reader product (module or finished product) suppliers and overall solution providers. In the domestic market,due to the rise of competing technologies such as QR code and biometrics, the HF RFID card market has declined a lot, but it has begun to stabilize in recent years.

Tag products include Inlay, semi-finished labels, finished labels and other products. High-frequency RFID tags are similar to UHF RFID tags. Players are mainly production companies with a relatively clear division of labor. However, compared with UHF RFID, high-frequency RFID applications are relatively scattered.

Whether it is card products or tag products, they focus on production, the technical threshold is relatively low, and fixed investments such as the purchase of production equipment and factory buildings are required. At present, HF RFID production equipment (including packaging and composite equipment) is mainly domestic equipment.

Readers and writers are mainly divided into two categories. One is standard reader and writer IC products, including access control, POS machines and other card products that use standard reader and writer ICs. At present, the NFC chip in the mobile phone is also equivalent to a standardized reader, and the NFC of the mobile phone can directly read most high-frequency RFID products on the market. In many customized application scenarios, the reader and writer is built with discrete components to better meet the needs of the project in terms of performance and cost.

In summary, in the high-frequency RFID market, card and tag products focus on production, and the unit price of the product is relatively low, and the volume needs to be increased; while the technical threshold of reader and writer products is relatively high, but the market demand will be much smaller, especially the discrete component method is more customized, the volume is not large, and the price is too high, which will make it difficult for users to accept, so many of these companies are doing overall solutions to obtain more market value.

3.1.3 Downstream of the industrial chain

The downstream refers to the end users and system integrators of various applications. According to the product form, HF RFID applications can be divided into three major markets: card applications, tag applications, and electronic products (HF chips are directly embedded in the circuit boards of electronic products).

At present, the common cards in our daily life include bank cards, bus cards, campus cards, and membership cards for various consumption, which are mostly HF RFID products. Tickets for large-scale entertainment activities such as concerts, carnivals, and festivals also use high-frequency RFID products; ID cards and social security cards are also high-frequency RFID products in terms of frequency band, but this is a special market and is not within the scope of this white paper. In summary, the application scenarios of tickets and cards are all people-centered, based on the needs generated

by people's consumption, travel and other activities; although the ticket and card market is gradually shrinking, the stock market is still large.

Tag applications are the fastest growing application area of HF RFID. Compared with card products, tag products are smaller, thinner and cheaper. Currently, HF RFID tags are used more frequently in book archives, anti-counterfeiting traceability, unmanned retail, etc. The application of tags is mainly based on the management needs of items. In terms of quantity, there is more imagination. This is also the main incremental market of high-frequency RFID. In addition, tag products do not have a long service life like cards. In many fields, tag products are disposable consumables, and the market is updated faster. The HF RFID market for electronic products is an emerging scenario in recent years.

Electronic products plus NFC chips can easily realize the pairing of mobile phones and electronic products, simplify the online pairing process of electronic products, and can also perform anti-counterfeiting traceability management. In the field of electronic price tags, NFC can help merchants conduct more accurate marketing.

3.2 Analysis of China's HF RFID Passive IoT Market Opportunity Model

Reference to the analysis model of UHF RFID, we mainly evaluate the industry market opportunity model of China's HF RFID from five dimensions, and in order to better quantify the market, we give each dimension a score (1-10 points):

1. Industry certainty: Comprehensively evaluate the policies of each sub-industry, the layout of industry giants, the market demand of the industry and other driving forces and demand, and evaluate the certainty of the sub-industry. The higher the certainty, the higher the score.

2.Industry market ceiling: This dimension judges the upper limit of the market ceiling of HF RFID in each sub-scenarios (based on shipments), and concludes how large the potential market of the industry is. The higher the ceiling, the higher the score.

3.Industry standardization: This dimension evaluates the product standardization of HF RFID in various sub-scenarios and whether it can be quickly replicated and expanded. The higher the standardization, the higher the score.

4.Industry entry threshold: This dimension evaluates whether the entry threshold of HF RFID in various sub-scenarios is high (including technology threshold, market qualification and resource threshold, capital and channel threshold, etc.). A high threshold means fewer players entering, relatively less competitive pressure, and relatively greater market opportunities. The higher the industry threshold, the higher the score.

5.The ability of HF RFID technology to replace other technical products: This dimension evaluates what other technical solutions are currently available for HF RFID in various sub-scenarios, and how HF RFID technology can replace them compared with these solutions (the degree of improvement in technical performance, price level, etc.). If HF RFID is an innovative application in a certain sub-sector (that is, there are no other competing technical solutions), it means that HF RFID is scarce in this field, and the score for this item will be relatively high. The stronger the ability of HF RFID to replace other technologies, the higher the score.

32 China HF RFID Industry Segment Market Opportunity Analysis Model

	Degree of certainty	Market ceiling	Degree of standardization	Entry barriers	Ability to replace existing technologies	Total score
Finance	6	5	6	7	5	29
Transportation	5	5	6	7	5	28
Access control	4	5	5	5	4	23
Campus	5	5	5	5	4	24
Anti-counterfeiting and traceability	4	8	5	5	6	28
Book archives	5	7	5	4	4	25
Contactless social networking	3	3	5	4	3	21
Unmanned retail	2	7	4	3	4	20
Electronic products	3	8	4	4	5	24
Industrial production	2	6	3	4	4	19
Electronic price tags	7	6	6	6	6	31

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Based on the market opportunity model of HF RFID, we can summarize the following points:

The first-tier segmented application scenarios are: finance, transportation, electronic price tags and anti-counterfeiting traceability. Among them, finance and transportation are mainly card products, which are traditional markets, while electronic price tags are emerging application scenarios in recent years. At present, NFC functions are already standard in electronic price tag products, and the annual volume is several hundred million.

The second-tier segmented application scenarios are: access control, campus, library archives, electronic product pairing and other fields. Among them, access control and campus are also traditional application scenarios for card products. Although there are not many growth points, they are relatively stable. The current volume of electronic product pairing is not large, but this field has great potential, and we have seen that NFC is currently rapidly penetrating in this scenario.

Other application scenarios belong to the third tier. These scenarios also use HF more, but for various reasons, the growth potential is limited.

3.3 Analysis of China's HF RFID passive IoT industry market operations

The HF industry is mainly concerned with the quantity of tags. Although the quantity of HF readers is also large, the unit price is low and the application is scattered. Therefore, in the HF RFID chapter, we mainly analyze the Chinese HF RFID tag market.

3.3.1 Analysis of HF RFID tag market shipments by Chinese manufacturers

In this survey, we combined the information of mainstream chip manufacturers, antenna manufacturers, tag manufacturers, and card manufacturers, and evaluated the overall HF RFID shipments of Chinese manufacturers. The detailed data is shown in the table below:

33 Shipments of various HF RFID tags by Chinese manufacturers (unit: 100 million pieces)
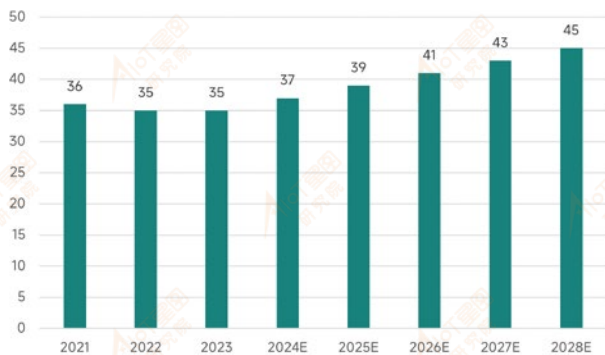
Data description:

1. The scope of this data statistics is: the total shipment data of domestic HF RFID tag factories, of which the chips include the data of domestic chip manufacturers and overseas chip manufacturers in the domestic market, and the end users also include domestic users and overseas users.

2. In the past few years, the HF tag market has shown a certain downward trend due to the rapid decline in the issuance of bank cards, but after bottoming out and stabilizing in the past two years, the entire HF tag market will show a slight growth trend in the future.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3.3.2 Analysis of domestic chips and overseas chips in China's HF RFID tag market

What is the proportion of domestic chips in China's HF RFID tag market? This white paper also conducted an analysis, and the results are as follows:

34 Analysis of domestic chips and overseas chips in China's HF RFID tag market (unit: 100 million pieces)

Data description:

1. Fudan Micro has the largest share of domestic HF RFID tag chips, while overseas chip manufacturers are mainly NXP and ST.

2. According to our statistics, the shipment volume of overseas chip manufacturers in China is relatively stable, while domestic chips maintain a small growth trend.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3.3.3 Analysis of domestic and overseas users in China's HF RFID tag market

In order to better study the Chinese HF RFID tag market, this year's version has added an analysis of the proportion of domestic and overseas users in the HF tag market.

35 Analysis of domestic and overseas users in China's HF RFID tag market (unit: 100 million)

Data description:

1. Domestic users refer to users whose decision makers for the application are domestic users, and overseas users refer to users whose decision makers are foreign-funded.

2. The application customers of domestic HF tag factories are mainly overseas customers.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

3.3.4 Analysis of Shipment Volume of HF RFID Tags in Major Market Segments for Domestic Users in China

This white paper evaluates and predicts the shipment volume of HF RFID in major segments of domestic users, and the results are as follows:

36 Shipment Volume and Forecast of Major Application Segments of HF RFID Tags in Domestic Users in China (Unit: 100 million pieces)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Finance	3.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5
Access control	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3
Transportation	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Campus	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Anti-counterfeiting and traceability	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Book archives	2.5	2.5	2.5	3.0	3.0	3.5	3.5	4.0
Unmanned retail	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5
Electronic product matching	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7
Industrial production	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
Electronic price tags	0.7	1.0	1.0	1.1	1.2	1.3	1.4	1.5
Others	2.0	2.0	2.1	2.2	2.3	2.4	2.5	2.6
Total	12.7	11.6	11.7	12.9	13.8	15.0	16.0	17.3

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Supplementary explanation of segmented markets:

① Finance

The application of HF RFID in the financial field is mainly various types of bank cards, including debit cards, credit cards and other card products. According to public information on the Internet, the annual increase in the issuance of bank cards in China has shown a cliff-like decline. In the past few years, the annual increase in the issuance of bank cards was several hundred million, while in recent years, the annual increase in the issuance of bank cards was only tens of millions. With the saturation of bank card penetration and the change of people's payment habits, it is expected that the annual issuance of bank cards in the future will be stable at tens of millions.

② Access control

The access control market is another common application of HF RFID, including residential communities, factory parks, office buildings, hotel apartments and many other applications that require access control cards.

Although facing challenges from other emerging technologies, access control cards are still widely used, especially for some special groups, such as the elderly, children, etc., and there is also a rental market, including the rental of ordinary residential houses and hotel apartments.

The domestic access control card volume is expected to be stable at tens of millions per year, but the access control card market is mainly overseas, and the main market for domestic manufacturers is also exported overseas.

③ Transportation

HF RFID has a wide range of applications in the field of transportation, among which the most important are cards in the field of public transportation and corresponding reader-writer equipment. There is no relevant public information disclosure on the Internet about the number of transportation cards issued in the Chinese market. According to the information we have surveyed, the number of new cards issued for various types of bus cards each year is about 10 million, and it is relatively stable, and some specific groups still need to use it.

④ Campus

The campus is a place where many students study and live together. During the school period, students' activities such as dining, shopping, water, electricity, book borrowing, medical treatment, and building entry and exit involve payment, identity authentication, and water and electricity consumption management. All aspects require the use of campus cards.

According to the data from the Ministry of Education, except for kindergartens, the number of students in schools at all levels in China remains between 230 million and 250 million. The new market mainly considers the important nodes from kindergarten to elementary school, elementary school to junior high school, junior high school to high school, and high school to university. The annual new potential is about 50-60 million. However, the penetration of campus cards in schools at each stage in each region is different, and the selected solutions are also different. Overall, it is estimated that the annual new market for campus cards is about tens of millions.

⑤ Anti-counterfeiting traceability

Because HF RFID tags have good security and can interact with mobile phones, they are very suitable for anti-counterfeiting traceability. In the market, the use of HF RFID tags for anti-counterfeiting traceability is already very common, especially in some high-value and precious products, where the demand for anti-counterfeiting traceability is relatively strong.

For example, high-end liquor (Moutai, Wuliangye, etc.), tobacco, tea, as well as jewelry, luxury goods and other valuable items are widely used. The annual consumption of China's mid-to-high-end liquor is estimated to be about 500 million to 1 billion bottles.

Some projects use dual-frequency (high frequency and ultra-high frequency) RFID tag products for anti-counterfeiting and traceability. According to our research, anti-counterfeiting and traceability will become an important incremental market for HF RFID tags in the future.

⑥ Books and archives

The field of books and archives is also an important application scenario for HF RFID tags. In the UHF part, we have analyzed the library scenario. In the domestic library market, UHF and HF are both mainstream solutions.

Because HF RFID appeared earlier, the HF solution was used in the early library market. Even though the cost of UHF RFID tags is very low now, HF tags still have their unique characteristics in the library market, such as good stability and high accuracy, so HF still has a good market.

In the previous content, we estimated that the capacity of the entire domestic book and archive market is about 10 billion pcs or more. At present, the annual market growth of domestic library tags is about 500-1 billion. According to rough estimates, HF RFID also has a volume of several hundred million per year. In addition, in overseas markets, the market usage of HF RFID books and archives is also relatively large, which may be a new growth point in the future.

7 Unmanned retail

Although the enthusiasm for unmanned retail has been extinguished after the concept hype, some projects are still retained in the market, including the solution of using HF RFID tags. In addition, there are also cases of HF RFID landing in some unmanned vending terminals of fresh food retail. Although there is no outbreak trend at present, it is estimated that there will be a stable volume of tens of millions per year.

8 Electronic product pairing

Electronic product pairing is an application scenario that we have noticed in recent years. The first step to buy electronic products is to pair them with mobile phones and connect to the network. Previously, BLE was mainly used to achieve such pairing function, but BLE operation is not very convenient, especially for the elderly.

Based on such needs, the method of pairing with NFC has a market. BLE can be awakened by touching NFC, which can simplify the pairing operation a lot. In addition, when there are more smart products at home, if the operation is not very convenient, you can also use NFC to touch and control.

9 Industrial production

Industrial production is another common application scenario of HF RFID. In industrial production, HF is often used for process management, and tags are also used on vehicles. Compared with UHF, its advantage is that it is not easy to read in series, and its disadvantage is that the reading distance is too short. At present, there are many industrial scenarios in the market that use HF solutions, and the volume of this scenario is expected to be tens of millions.

10 Electronic price tags

Electronic price tag products have been equipped with NFC functions as standard. At present, the global annual shipment volume of electronic price tags is about 300 million, and the total volume of this market is still considerable, but the volume of domestic brands is about 100 million.

The main demand for NFC in electronic price tags is: on the one hand, it is convenient for consumers to interact with supermarkets. Consumers can check more detailed information about the product or promotional activities such as coupons after touching it; on the other hand, it adds an alternative plan for the operation of electronic price tags. At present, the connection of electronic price tags is mainly Bluetooth or 2.4G. If the on-site network fails, supermarkets can also use mobile phone NFC to control the electronic price tags.

11 Other application scenarios

In addition to the above application scenarios, high-frequency RFID has many other application scenarios, especially ticket and card scenarios, such as consumer membership cards, hospital diagnosis and treatment cards, etc. The total amount of these scenarios is also relatively large.

3.3.5 Analysis of China's HF RFID Market Output Value

Regarding China's HF RFID market output value, our evaluation dimension is based on the shipment data of domestic manufacturers. To evaluate China's HF RFID market output value, it is necessary to include the shipment volume, price, system software and service value of various products. Through our research, we have conducted the following evaluation of China's HF RFID market output value.

37 China's HF RFID market output value (unit: 100 million yuan)
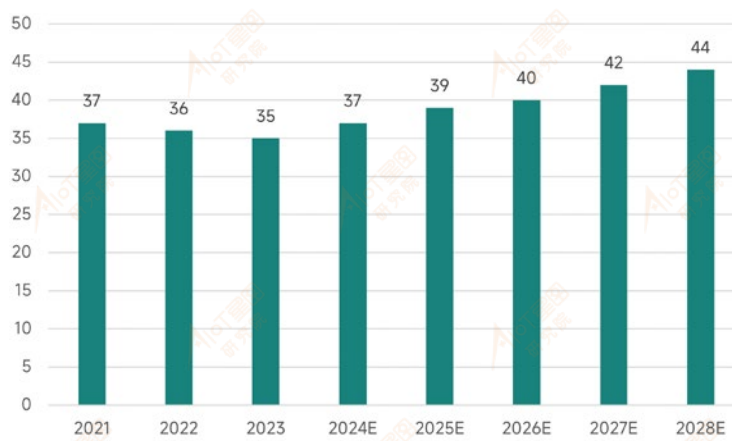
Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data description:

1. The HF RFID output value evaluates the output value of Chinese manufacturers, including the output value of domestic manufacturers' hardware and the system output value of domestic end users.

2. The output value of high-frequency RFID is mainly card products. Card products not only account for a large proportion in quantity, but also have a much higher price than tag products.

3. The number of high-frequency RFID readers is expected to reach tens of millions; however, the price of high-frequency readers is relatively cheap. Overall, high-frequency reader products contribute more output value.

4. In some scenarios, such as electronic product pairing and electronic price tags, we only count the output value of chips, because the terminal value of such products is relatively expensive and they do not belong to tag products.

5. Most of the end users of HF RFID are overseas customers. The domestic industry chain mainly earns the value of hardware in the overseas market, and the price is relatively low.

3.4 Summary of the latest trends in China's HF RFID passive Internet of Things industry

Through this survey, we have summarized the following latest trends in the high-frequency RFID industry

Trend 1: High-frequency NFC is unlocking many new application scenarios

The biggest advantage of HF compared to UHF is that there is NFC on the mobile phone. NFC based on the mobile phone can unlock many new application scenarios. For example, we have seen a large number of home appliances and NFC to achieve convenient pairing, so as to perform network configuration, control and other operations. In addition, NFC can also be combined with wireless charging, and NFC can be used to realize wireless charging. Such new NFC scenarios are worth looking forward to in the future.

Trend 2: There will be more and more dual-frequency solutions that integrate HF and UHF.

The biggest advantage of HF products is that they can interact with mobile phones, while UHF products can achieve rapid inventory at the supply chain end. Therefore, the dual-frequency solution that combines the capabilities of both has become a highlight of the market. High-end wines, luxury goods, or valuable items with high value are suitable for this solution.

Trend 3: The proportion of books and archives in HF solutions is gradually decreasing.

According to the information we have surveyed, domestic books and archives have obviously switched to UHF RFID solutions in recent years. In addition to the old projects of public libraries that are still using HF RFID solutions, new projects are basically based on UHF RFID solutions.

Trend 4: HF anti-counterfeiting and traceability scenarios are worth looking forward to

Anti-counterfeiting and traceability is a market with wide application potential, and this scenario requires interaction with mobile phones. This is the advantage of HF RFID. It is currently only used in high-end liquor and some high-value products. In the future, it is expected that there will be a strong policy push to promote the development of this market.

Trend 5: After the reshuffle, the remaining players will maintain good profits

High-frequency products are more expensive than ultra-high-frequency products, and the application of high-frequency products is more fragmented, so the companies that remain to make high-frequency products can maintain a relatively good gross profit level.

Trend 6: High proportion of domestic substitution of high-frequency products

At present, the domestic substitution rate of HF RFID is already very high. At the chip level, according to our statistics, the proportion of domestic chips in the domestic label market has exceeded 80%, and in terms of production equipment, the degree of localization of HF tags, such as binding, compounding, and later inkjet printing, is very high.

Part 4
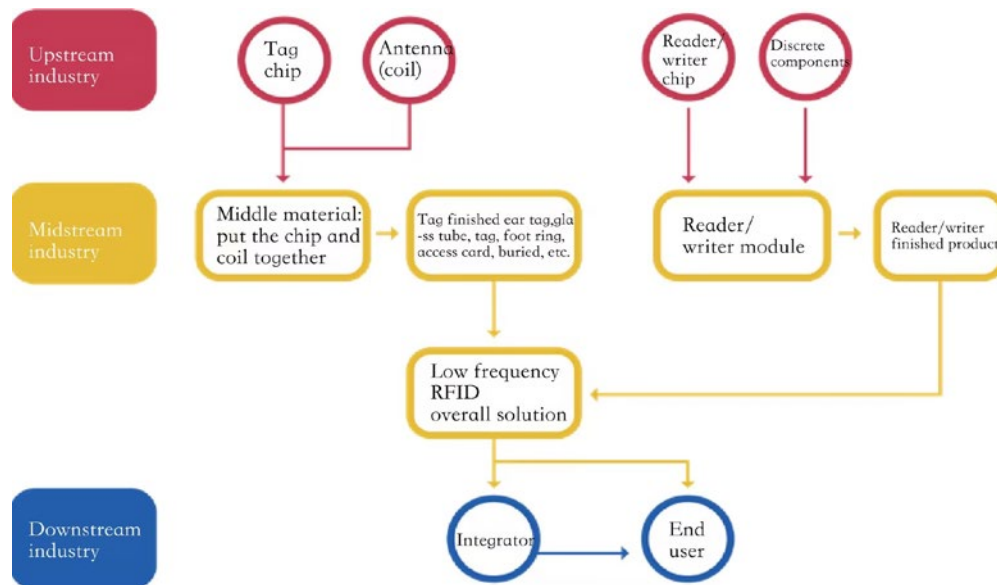## China LF RFID Passive Internet of Things Industry

4.1 Analysis of China LF RFID Passive Internet of Things Industry Chain

LF (low frequency) RFID works at a relatively low frequency, with typical working frequency bands of 125KHz and 134KHz. It mainly works through inductive coupling, and its working principle is the same as HF RFID.

Low frequency RFID has been commercialized for a long time, and the technical threshold is relatively low. In terms of volume, the proportion of low frequency RFID is not large, but some of its unique technical characteristics have irreplaceable advantages in certain application fields, such as good anti-interference performance, especially good anti-liquid, anti-metal, and anti-blocking performance. However, it also has disadvantages such as low transmission speed and short working distance.

Although there are not many players in the entire low frequency RFID industry at present, there are still a group of companies working hard in this market.

Low frequency RFID industry chain

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

4.1.1 Upstream of the industry chain

The upstream of low frequency RFID is chips and antennas (coils).

Low-frequency RFID chips are divided into tag chips and reader chips. The tag chips are relatively large in quantity. Major players can refer to the "IOTE·China RFID Passive Internet of Things Industry Atlas (2024 Edition)" in this white paper.

Low-frequency RFID tag chips can be divided into two categories. One is read-only products. This type of product has low cost and relatively large quantity. The main application areas are access control cards, key chains and other identity recognition scenarios; the other is products that can be read and written. The price of this type of product is relatively high. The main application areas are animal tags, industry, and buried tags.

Low-frequency RFID reader chips can also be divided into two categories. One is the card market. This market has a relatively large

volume. One access control requires a reader, and it only reads but does not write. Therefore, the reader for this type of scenario has standardized chip products. The other market is products that need to be read and written, mainly animal tags, buried tags, etc.; the cost of this type of product is relatively high, and the current market demand is small. Generally, discrete components are used to build it.

Antennas (coils) focus on the production process, and do not have too many technical barriers. They require labor investment and fixed asset investment such as production equipment and factories.

38 Summary of major LF RFID tag chip manufacturers and product features

Chip manufacturer	Frequency band	Chip model	Supported protocols/ standards	Memory(bit)	Applicable scenarios	Features
Quanray Electronics	125KHz/134.2KHz	QJupi-6U (J6U)		128	Industrial Asset Management	Secure encryption
Excelio technology	130-138kHz	EL9265	ISO 11784/11785 full-duplex communication standard	512	Animal Identification, Livestock and Pet Management, Home Health Care	Integrated temperature sensor
	130-138kHz	EL8165A2	ISO 11784/11785	512	Animal identification, livestock management, asset tracking	
	130-138kHz	EL8265A2	ISO 11784/11785	512	Animal identification, livestock management, asset tracking	
	130-138kHz	EL8265A1	ISO 11784/11785/14223	512	Animal identification, livestock management, asset tracking	
	130-138kHz	EL9165	ISO 11784/11785 half-duplex communication standard	512	Animal Identification, Livestock and Pet Management, Home Health Care	Integrated temperature sensor
	100-150 kHz	EL8265A0		512	Access control, duplicate card, and duplicate keychain market	
	117-133kHz	EL8200C2	Read-only access card ID-64 standard	64	Access control, asset management, key ring, etc.	
Nanjing CSM-IC Microelectronics Co., Ltd.	15kHz-150kHz	Si3933/Si3933(QFN16)			Access control, asset management, key ring, etc.	
Shenzhen Huasen Company Limited	125KHz	HST0068			Access control, attendance, one-card and other scenarios	
NXP	100 kHz to 150 kHz	HITAG μ / Advanced / Advanced+	ISO 11784/85 ISO 14223	512 - 1760	Livestock Management	
	100 kHz to 150 kHz	HITAG S	ISO 11784/85	256 - 2048	Livestock Management	
	100 kHz to 150 kHz	HITAG RO		64-bit pre-programmed	Industry	
	100 kHz to 150 kHz	HITAG 2	HITAG 2 ISO 11784/85	256	Livestock Management	
	125 kHz	HITAG 1	HITAG 1	2048	Logistics Tracking	
	125 kHz	HITAG 1	HITAG 1	2048	Logistics Tracking	
EM	100 to 150 kHz	EM4205/ EM4305	ISO 11784 / 11785	512	Animals, pigeons, waste management standards, access control, etc.	
	100 to 150 kHz	EM4200	ISO11785 (FDX-B)		Animal management, waste management, industry, etc.	
	100 to 150 kHz	EM4450		1 K	Ticketing, car anti-theft, industrial automation, etc.	
	100 to 150 kHz	EM4582	ISO9798-2	8.5K	Car anti-theft, access control, hotel, parking, etc.	
Taiwan smartchip limited company	125KHz□134.2KHz	SMC 4001/4100/ 4305/5577/4005			Logistics, toys, livestock, pets, access control, etc.	

Chip manufacturer	Frequency band	Chip model	Supported protocols/standards	Memory(bit)	Applicable scenarios	Features
Silicon Craft	125-134.2 KHz	SIC7888/SIC278	General Purpose FDX LF IC ISO11784/11785 FDX-B LF IC ISO11784/11785 HDX LF IC		Access control, animal tracking, automobiles, equipment management	FDX-B full-duplex chip
	125-134.2 KHz	SIC279	General Purpose FDX LF ICISO11784/11785 FDX-B LF ICISO11784/11785 HDX LF IC		Food traceability, industrial automation, logistics management, waste management	HDX half-duplex chip

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

39 Summary of major manufacturers and product features of LF RFID reader chips

Chip manufacturer	Frequency band	Chip model	Applicable scenarios
NXP	100 kHz to 150 kHz	HTRC11001T	Livestock tracking, logistics
EM	100 to 150kHz	EM4095	Automobile anti-theft systems, handheld readers, low-cost readers
	100 to 150kHz	EM4097	Animal ID readers, handheld low-frequency readers

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

4.1.2 Midstream of the industry chain

The midstream of low-frequency RFID mainly includes low-frequency tag product manufacturers, low-frequency reader product manufacturers, and overall solution providers. Low-frequency RFID has been commercialized for a very long time. After years of running-in, the supply and demand of the entire market has long been balanced, and there are occasionally some new highlights. In the label link of low-frequency RFID, companies generally customize the shell and shape of products according to customer needs to form a variety of products, such as access cards, key chains, animal foot rings, ear tags, glass tags, buried tags, etc.

In the low-frequency reader link, because the overall market demand is relatively small, related companies generally have other businesses, and develop low-frequency RFID business through project customization. Because it is built with discrete components, the technical threshold is relatively high, so there are also companies in the market that make readers into modular products for sale.

In specific projects, users need both tag products and reader products. At this time, the market needs overall solution providers. Overall solution providers generally directly connect with end users or end users' integrators. They either develop their own or integrate tag products and reader products externally, and then customize some application software according to project requirements to provide customers with more complete services.

4.1.3 Downstream of the Industrial Chain

The downstream of low-frequency RFID is various end users and end users' integrators. Low-frequency RFID is a market that has experienced full competition. Because the technology is relatively old, it is gradually replaced by new technologies in many application markets. However, low-frequency RFID has a unique advantage, that is, it has very good anti-interference and is very stable. It has irreplaceable advantages in special application scenarios such as liquid environments or metal environments. Typical scenarios include animal tags (ear tags, glass tube tags, animal foot rings, etc.), industrial tags, buried tags, etc.

Of course, low-frequency RFID still has a stock market, namely smart cards, access cards, car keys, etc. Although it faces the risk of being replaced by other technologies, the maintenance demand of the market has always existed because of the large stock, and market degradation is also a long-term process.

4.2 Analysis of China's LF RFID Passive Internet of Things Market Opportunity Model

Referring to the analysis model in the previous chapter, we mainly judge the industry market opportunity model of China's LF RFID from five dimensions, and in order to better quantify the market, we give each dimension a score (1-10 points):

1. Industry certainty: Comprehensively consider the policies of each sub-industry, the layout of industry giants, the market demand of the industry and other driving forces and demand, and evaluate the degree of certainty of the sub-industry. The higher the degree of certainty, the higher the score.

2. Industry market ceiling: This dimension judges the upper limit of the market ceiling of LF RFID in each sub-scenarios (based on shipments), and concludes how large the potential market of the industry is. The higher the ceiling, the higher the score.

3. Industry standardization: This dimension evaluates the product standardization of LF RFID in various sub-scenarios and whether it can be quickly replicated and expanded. The higher the standardization, the higher the score.

4. Industry entry threshold: This dimension evaluates whether the entry threshold of LF RFID in various sub-scenarios is high (including technology threshold, market qualification and resource threshold, capital and channel threshold, etc.). A high threshold means fewer players entering, relatively less competitive pressure, and relatively greater market opportunities. The higher the industry threshold, the higher the score.

5. The ability of LF RFID technology to replace other technical products: This dimension evaluates what other technical solutions are currently available for LF RFID in various sub-scenarios, and how LF RFID technology can replace them compared with these solutions (the degree of improvement in technical performance, price, etc.). If LF RFID is an innovative application in a certain sub-sector (that is, there are no other competing technical solutions), it means that LF RFID is scarce in this field, and the score for this item will be relatively high. The stronger the ability of LF RFID to replace other technologies, the higher the score.

40 China LF RFID Industry Segment Market Opportunity Analysis Mode

	Degree of certainty	Market ceiling	Degree of standardization	Entry barrier	Ability to replace existing technologies	Total score
Animal field (livestock)	5	6	5	5	5	26
Animal field (pets)	4	5	5	4	5	23
Animal field (poultry)	2	5	4	4	3	18
Animal field (scientific research)	2	5	3	4	3	17
Access control	2	4	4	2	2	14
Car keys	2	4	5	4	2	17

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Data Description:

1.LF RFID has relatively few application scenarios, mainly concentrated in animal management. For better research, this white paper subdivides LF RFID animal management scenarios into livestock (pigs, cattle and sheep), poultry (pigeons, chickens, ducks and geese), pets (cats and dogs), and scientific research experiments (mice, etc.). Among them, livestock and cats and dogs have a higher demand for LF RFID, so the score will be higher.

2.In addition to animal management, the most common scenarios for LF RFID are access cards and car keys. However, these two scenarios are currently facing the risk of being replaced by emerging technologies, so the scores are relatively low.

4.3 Analysis of China's LF RFID passive IoT industry market operation

4.3.1 Analysis of Chinese manufacturers' LF RFID tag market shipments

There are relatively few players in the low-frequency RFID industry, especially chip players. After combining the data of several major low-frequency chip suppliers, we evaluated and predicted the entire low-frequency RFID market shipments.

**41 Analysis and forecast of China's LF RFID tag shipments (unit: million)**

Data description:

1.According to our survey data, the global shipment of low-frequency RFID tags is about 800 million, and Chinese manufacturers account for about 40%. Compared with the previous version, we have revised the market data.

2.The largest use of low-frequency RFID tags is animal management, accounting for more than 60%, and the main market in this field is abroad; followed by access control cards, the application market in this field is also mainly overseas, but the suppliers are mainly concentrated in China; in addition, the volume of car keys has also been relatively stable.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

4.3.2 Analysis of domestic and overseas users in China's LF RFID tag market

42 Analysis of domestic and overseas users in China's LF RFID tag market (unit: million)

国内用户 ■ 海外用户
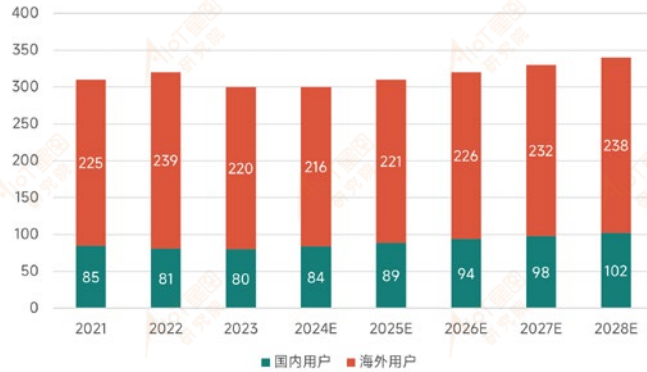
Data description:

1.The main customer market of domestic LF RFID tag manufacturers is overseas, and the domestic user demand accounts for a small proportion.

2.Whether in the domestic user market or the overseas user market, the demand for LF RFID tags is relatively stable.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

4.3.3 Analysis of shipment volume of LF RFID in major market segments for domestic users in China

According to our research information, the main application markets of low-frequency RFID include animal tags (including pets, livestock, poultry, etc.), access control, car keys, etc.

43 China's domestic users LF RFID market main segment application field shipment and forecast analysis (unit: million)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
Animal field (livestock)	22	20	20	22	24	26	28	30
Animal field (pets)	5	5	5	6	7	8	9	10
Animal field (poultry)	4	5	5	5	6	6	6	6
Animal field (scientific research and experiment)	3	4	5	6	7	8	9	10
Access control	12	11	10	10	9	9	8	8
Car keys	12	11	10	10	10	10	10	10
Electricity	6	5	5	5	6	6	7	7
Semiconductor carriers	5	5	5	5	5	5	5	5
Others	16	15	15	16	18	20	22	24
Total	85	81	80	84	89	94	98	102

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Supplementary explanation of the market segment:

1 Animal field (animal husbandry)

China has a large population, and the number of livestock such as pigs, cattle, and sheep consumed each year is also very large, especially pork, which is the main meat for the people. It is understood that Chinese people eat 700 million pigs every year. The RFID tags on pigs are mainly in the form of ear tags. If all RFID ear tags are installed, theoretically, the number of tags consumed in this market each year is also hundreds of millions.

According to public information on the Internet, the number of cattle raised in China is about 60 million, and according to information from China Business Information Network, China's current annual sheep inventory is about 300 million. Because the breeding of cattle and sheep is supported by policies, some areas in China have launched insurance policies for cattle and sheep, that is, injecting glass tube tags into cattle and sheep. If the insured cattle and sheep die due to disease and disaster, the breeder can get a certain amount of insurance compensation, and the insurance company uses RFID tags to confirm whether the dead cattle and sheep are insured.

Judging from the current industry information, UHF RFID solutions are mostly used for pig farming, while LF RFID tags are mostly used for cattle and sheep breeding tags because they need to be injected into the body.

2 Animal field (pets)

As early as 2008, Beijing proposed to promote dog chips; from 2017 to 2019, cities such as Suzhou, Ma'anshan, Baotou, Hangzhou, and Shenzhen successively issued management regulations related to the injection of dog chips. The so-called dog chip is that the pet owner injects the pet dog with a glass tube tag containing a low-frequency RFID chip while registering the dog tag for the dog.

According to public data statistics on the Internet, the total number of cats and dogs in China exceeds 100 million, which is only the data that can be counted. There are still many cats and dogs in remote rural areas that have not been counted. The potential of this market is still relatively large, but this market needs policy support. Currently, only some cities have begun to use it.

3 Animal field (poultry)

The management of poultry is mainly pigeon leg rings. Racing pigeons are an increasingly popular project, and the management of racing pigeons is basically through RFID tags. It is understood that there are about a few million tags consumed in this scenario every year. In addition, some poultry such as chickens, ducks, and geese are also managed with leg rings.

4 Animal field (scientific research experiments)

In scientific research experiments, especially in the biopharmaceutical industry, a large number of mice are used for experiments, and a small number of monkeys are also used for experiments. It is understood that in the United States alone, the number of experimental mice consumed each year is about 20 million, and the number of mice used worldwide is about 50-60 million each year.

Mice have strong management needs. Enterprises and scientific research institutions need to manage mice by number. In addition, they also need to monitor their vital signs. In recent years, the use of low-frequency RFID tags + temperature sensor products in this field is increasing rapidly.

5 Access control

Access control is another important application area of low-frequency RFID. Low-frequency has been commercialized for a long time and has been used for access control for a long time. In the previous chapter, when analyzing the high-frequency RFID market, we briefly introduced the access control market. According to the information we have surveyed, low-frequency technology products account for a large proportion of the current access control cards.

However, in general, the access control card market is shrinking due to the emergence of many other emerging technologies. Specifically, high-frequency and low-frequency cards are replacing some low-frequency card markets because high-frequency cards have more cost advantages than low-frequency cards.

6 Car keys

Another important application of low-frequency RFID is the anti-theft key system of cars. The function of this anti-theft system is not only to open the car door, but more importantly, when the car is ignited, the key needs to be used for identity recognition before the car engine can be started normally.

The annual global sales of new cars are about 70-80 million. In addition to the loss of car keys in the existing market, the annual demand for car keys is expected to be about 100 million, but the Chinese market accounts for a small proportion.

Car keys have faced many challenges from emerging technologies in recent years. For example, digital car key solutions such as NFC, BLE, and UWB are rapidly emerging, which have a great impact on traditional car key solutions. This market is expected to show a certain downward trend in the future.

7 Electricity

The power market is a key application area for RFID tags. UHF RFID solutions are used in large-volume scenarios such as electricity meters and power asset inventory, but LF RFID tags are also used in some special scenarios, such as buried tags and some harsh environments. LF RFID tags are also used. The annual volume is not large, but the unit price is expensive.

8 Semiconductor carriers

The management of semiconductor carriers currently uses LF RFID solutions, and LF RFID tags are used to track the entire production process of chip wafers. The annual volume of this market is several million, which is relatively stable, but the unit price is very high.

9 Other application areas

In addition to the above-mentioned major application areas, low-frequency RFID has some other application areas, mainly including various cards and industrial fields, especially the total volume of various cards is quite considerable.

4.3.3 Analysis of China's LF RFID market output value

In our survey, we combined the information of the main players in the market, and evaluated and predicted the market output value of the entire LF RFID from the quantity and corresponding prices of various products, combined with the growth trend.

44 China's LF RFID market output value (unit: 100 million yuan)

Data description:

1. The scope of China's LF RFID output value assessment is China's industrial chain market, which includes many markets exported to overseas.

2. The average unit price of LF RFID products is relatively high, the highest among the three frequency bands, and the price is relatively stable.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

4.4 Summary of the latest trends in China's LF RFID passive IoT industry

Trend 1: The industry is stable, there are few players, and the competition is not fierce

After a long period of market adjustment in the supply and demand market, the supply and demand sides of low-frequency RFID have been very stable, and there are fewer players. It is a fully competitive market, and the industry's gross profit can maintain a good level.

Trend 2: The low-frequency card market will have a more obvious downward trend

The low-frequency card market includes access control cards, hospital treatment cards, consumer membership cards, etc. In the domestic market, card products have been largely replaced by other technologies, and in the foreign market, although card products are relatively stable, HF cards are also gradually replacing LF cards.

Trend 3: The animal market is the largest incremental market for low-frequency RFID

Currently, animal management is the main application market for LF RFID, accounting for more than 60%, because in the animal field, LF RFID has irreplaceable advantages over other technologies, such as anti-liquid interference performance. With the gradual development of the smart agriculture industry, the application of LF RFID in animal management (including animal husbandry, cats and dogs, experimental mice, poultry, etc.) is gradually increasing.

Trend 4: Projects are relatively scattered, and the industry is highly customized

Low-frequency RFID projects are not as standardized as UHF, and the degree of customization is high, so industry players are gradually developing from single products to solutions. There are also many companies doing high-frequency RFID, ultra-high-frequency RFID, and even other businesses at the same time, which is also related to the current situation of the industry where the low-frequency RFID market is relatively small and customization is serious.

Part 5
China RFID Passive Internet of Things Auxiliary Industry Chain

RFID auxiliary industry chain is an indispensable part of the development of RFID industry, which can help us better understand the cognitive industry. This white paper focuses on the analysis of the two auxiliary industry chain links of RFID tag antenna and production equipment.

5.1 RFID tag antenna

Overview of RFID tag antenna industry

RFID antenna includes tag antenna and reader antenna. Reader antenna is common with other types of wireless radio frequency technology (WiFi, Bluetooth, etc.) antennas, without special features, and the quantity is relatively small.

Therefore, it is not within the scope of discussion of this survey. RFID tag antenna is more different from other wireless technologies, and the quantity is also large. Therefore, this chapter focuses on RFID tag antenna.

In RFID passive Internet of Things system, tag antenna plays an important role, because in other technologies such as WiFi, Bluetooth, 4G, 5G, etc., the antenna only plays the role of sending and receiving signals, while in RFID passive Internet of Things products, the function of the antenna is not only to send and receive signals, but also to obtain energy.

Due to the different frequency bands, low frequency (125KHz-134KHz), high frequency (13.56MHz), and ultra-high frequency (860MHz-960MHz), the styles of tag antennas are different.

Because the frequency band of low-frequency RFID is very low, and the working principle is inductive coupling, the antenna is coil-type, and the number of turns of the coil is large, and the process used is generally metal wire winding.

The working principle of the high-frequency RFID frequency band is also inductive coupling, and the antenna is also coil-type, but because the frequency is much higher than the low frequency, the number of turns of the high-frequency antenna is relatively small, and the metal wire winding process can be used, or the etching process can be used. In addition, the high-frequency antenna must also consider the requirements of the bridge. Therefore, the etching production process of the high-frequency RFID antenna is much more complicated than that of the ultra-high frequency RFID antenna.

Coil antenna

(a) 矩形环天线   (b) 圆形环天线
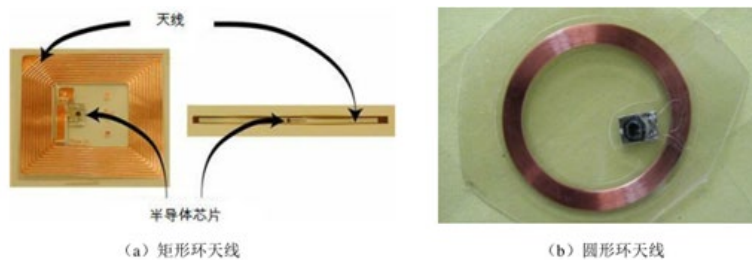
UHF RFID antennas generally use dipole antennas. The UHF RFID frequency band is 860MHz-960MHz, with a wavelength of about 30cm, and a half-wavelength of about 15cm, which is not very long. Therefore, UHF RFID tag antennas are suitable for half-wavelength dipole antennas.

Common tag dipole antennas

Production process of RFID tag antennas

There are several production processes for flexible RFID tag antennas, including etching, die-cutting, printing, etc. At present, the most important process in the market is etching, because etching antennas have good stability and high production efficiency. Although they face environmental protection and cost pressures, they are still the mainstream choice in the market at this stage.

Antenna production process	Advantages	Disadvantages	Application
Etching process	1. High production efficiency 2. Fine antenna shape and stable performance	1. There are more links of pollution	The mainstream process of UHF and HF tag antennas
Die cutting process	1. Fast production efficiency 2. Simple process and low cost 3. Less pollution	1. The antenna shape is slightly less refined	Currently widely used
Screen printing process	1. Fast production efficiency 2. Very little pollution	1. The performance and slurry formula need to be optimized 2. The cost is still relatively high	Currently a small number of applications
Laser cutting process	1. Fine antenna shape and stable performance 2. Less pollution	1. The production efficiency is low	Currently the technology is being improved

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Market introduction of RFID tag antenna

From the perspective of PCS, one RFID tag will correspond to one tag antenna, so the consumption of RFID tag antennas in 2023 will also be close to 50 billion.

The cost of UHF RFID tag antenna is also the lowest among several types of RFID. First of all, it has the largest volume and has scale advantages. Secondly, its process is relatively simple and consumes less raw materials. These are the reasons for the low cost of UHF RFID tag antenna. Low-cost antennas can promote the cost of the entire tag to be lower and more competitive in the application market.

The volume of HF RFID tag antenna is much smaller than that of UHF. Currently, several major UHF tag antenna players will also produce HF antennas simultaneously. The production process of HF etching antenna is more complicated than that of UHF, so the price of HF antenna is much more expensive than that of UHF antenna.

Due to the strict environmental protection policies in recent years, the production of RFID tag antennas has eliminated many small factories, which has indirectly raised the entry threshold of this market.

Trends and Challenges of RFID Tag Antennas

According to the information we have learned from the industry, the current trends and challenges of the RFID tag antenna industry are mainly the following:

1 Fierce price competition, thin profits for antenna manufacturers

Although a large number of RFID tag antenna manufacturers have been eliminated due to environmental protection requirements, the price competition among the remaining leading companies is also fierce.

2 The price optimization of aluminum etching process has reached the ceiling

Currently, the vast majority of RFID tag antennas on the market use aluminum etching process. The raw materials of antenna factories are mainly aluminum, substrates, hydrochloric acid and other chemicals. The price of raw materials has fluctuated greatly in recent years, and the domestic labor cost is also gradually increasing. Therefore, the cost optimization of RFID antennas using aluminum etching process has reached the limit.

In addition to aluminum antennas, there are also some copper antennas, but copper antennas are only used in a small number of scenarios because of the high price of raw materials.

3 The market needs new antenna technology to reduce the cost of labels

The price optimization of aluminum etching technology has reached its limit, so new technology is needed. There are currently two new technologies in the market that are used in small quantities. The first is die-cut antennas, and the second is printed antennas. In theory, these two types of antennas can be optimized in terms of cost, but to achieve large-scale applications, the production process needs to be mature.

4 New environmentally friendly antennas are gradually recognized by the market

Compared with traditional etching processes, there are currently two types of environmentally friendly antenna production processes:

One type uses physical cutting technologies such as die cutting and laser to produce antennas. This type of process reduces the use of chemicals compared to etching processes.

The other type is to mix metal powder particles with conductive glue into a special slurry, and then use printing technology to print the desired antenna model. In theory, this type of antenna can be naturally degraded through a reasonable slurry formula to achieve a more environmentally friendly purpose.

From the information we have surveyed, in developed countries, especially in Europe, environmentally friendly products are more valued, and the market is willing to pay a certain amount of extra expenses for environmentally friendly products. Therefore, environmentally friendly antennas are gradually gaining attention in the market.

5.2 RFID production equipment industry

There are many types of production equipment in the RFID industry chain, but the most core ones are packaging equipment (binding) and composite equipment. Therefore, in this chapter, we focus on analyzing these two types of equipment.

Of course, in addition to packaging equipment and composite equipment, there are some other equipment, such as high-speed detection equipment in the production process, label removal machines, label replenishment machines, and post-printing equipment, etc. This white paper does not conduct a separate analysis.

5.2.1 Packaging equipment

Introduction to the packaging equipment industry chain

Packaging equipment (binding machine) is the core equipment for RFID tag production. Its function is to package the RFID tag chip and antenna together to form Inlay.

The technical threshold of packaging equipment is high. Currently, packaging equipment on the market is mainly overseas brands. In recent years, the market share of domestic players has been increasing. For detailed information, players can refer to the "IOTE·China RFID Passive Internet of Things Industry Atlas (2024 Edition)" in this white paper.

Main indicators of packaging equipment

When judging the quality of packaging equipment, there are mainly the following indicators

1 Production efficiency

Because RFID tags focus on production, production efficiency is a very core indicator. At present, the equipment of overseas manufacturers can produce 40,000 tags per hour, while domestic equipment can produce about 10,000-20,000 tags per hour. In terms of production efficiency, there is still a large gap between domestic equipment and foreign equipment.

Because conductive glue generally needs 5-8 seconds of hot pressing to form an Inlay with stable performance, the hot pressing of conductive glue has become a "ceiling" that limits the production efficiency of packaging equipment. The market adopts a multi-head solution (2-3 tag binding modules) to increase production capacity.

2 Inlay stability and consistency

The performance stability of Inlay is also an important indicator of packaging equipment. Stability is reflected in the stability of RF performance and the chip's resistance to physical punching, while consistency is reflected in the good performance consistency of each label in mass-produced labels.

3 Product yield

At present, the yield of both domestic and foreign packaging equipment products is very high. In the process of mass production of RFID tags, it is inevitable that some tag products have poor performance due to various reasons. Such tags are generally removed as "waste labels" and need to be supplemented by manual or machine operations.

Trends in the packaging equipment industry

Through this survey, we have summarized several of the latest trends in the domestic packaging equipment industry

1 More and more domestic players

Packaging equipment is considered to be the link with the highest technical threshold in RFID tag production, so there are very few players. However, in our recent survey, more and more domestic players are eyeing this market. The main domestic players can refer to the "IOTE China RFID Passive Internet of Things Industry Atlas (2024 Edition)" in this white paper.

2 Domestic packaging equipment manufacturers need to do more customized content

The customers of packaging equipment manufacturers are label manufacturers, and label manufacturers have diverse businesses. Some only produce Inlay, some also produce white labels, and some produce finished labels. The performance and form of the labels are different. Therefore, in order to better meet the needs of users, domestic packaging equipment manufacturers need to make customized product solutions, not only providing a standardized binding machine equipment, but also customized supplementary supporting equipment.

In fact, several domestic binding machine players are currently doing this. In addition to packaging equipment, they also have compound machines, inkjet printers, high-speed testing equipment, label removal, label supplement machines and other businesses, evolving from providing a standard product to providing a complete set of intelligent production line solutions.

5.2.2 Compound equipment

RFID tag compounding is the next step in binding. The function of the RFID tag compounding machine is to compound the Inlay onto other materials and cut it into a label form that fits the application scenario. In some scenarios, the compounded label can be used directly, and in some scenarios, the label surface needs to be sprayed and printed after compounding before use.

Introduction to the compounding machine industry chain

Compared with the binding machine, there are many more players in the compounding machine market. The main domestic players can refer to the "IOTE China RFID Passive Internet of Things Industry Atlas (2024 Edition)" in this white paper.

However, the production efficiency of the compounding machine is much higher than that of the binding machine. Therefore, the incremental market of the compounding machine is mainly the influx of new players and personalized needs, because the compounding machine can produce a variety of label products according to customer needs.

The latest trends in the compound machine industry

1 Compound machine manufacturers are making more and more products and services

The competition for single compound machine products is becoming more and more fierce, and the gross profit is getting lower and lower. It is very stressful to survive by relying on a single product. Therefore, in order to find a way out, manufacturers will expand their product lines and shift from single products to providing a complete set of label production solutions. For example, packaging equipment, high-speed inspection machines, label removal, label replenishment machines, inkjet printers, etc. are all expandable business lines.

2 The rise of domestic applications will stimulate a new round of investment in the industry

Whether it is a binding machine or a compound machine, it is a heavy asset equipment with a large investment and a long service life. The general depreciation cycle is 8-10 years, which means that the incremental market for these devices mainly comes from the expansion of production capacity and the influx of new players.

Currently, RFID tags are mainly used in the field of footwear and clothing retail, and other scattered passive RFID applications are also rapidly emerging. The rise of these domestic applications will stimulate a new round of equipment investment.

Part 6
Summary of China's RFID Passive Internet of Things Market

In the previous chapters, we have analyzed in detail the industry chain, market and application of the three frequency bands of LF/HF/UHF of China's RFID passive Internet of Things. In order to better understand the market of RFID passive Internet of Things, in this chapter, we will summarize and analyze the shipment volume and market output value of RFID tags in the three frequency bands.

45 Total number of RFID passive Internet of Things tags produced by Chinese domestic manufacturers (unit: 100 million)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
LF	3.1	3.2	3	3	3.1	3.2	3.3	3.4
HF	36	35	35	37	39	41	43	45
UHF	67.1	82.4	97.7	113.5	144.1	184.8	225.4	306

■UHF ■HF ■LF
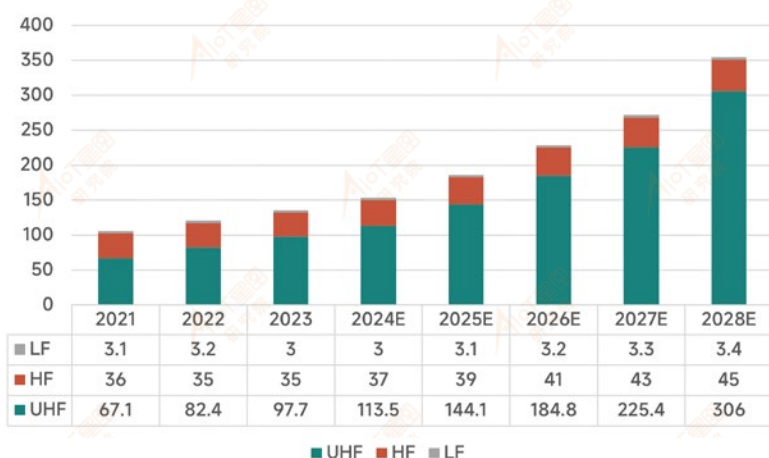
Data description

1. This table summarizes the shipment volume of RFID tags produced by Chinese domestic manufacturers, among which the UHF frequency band statistics are the summary of general and special tags produced by domestic manufacturers.

2. It can be seen intuitively that the proportion of UHF RFID frequency band will increase rapidly, and the industry is currently paying the most attention to the UHF frequency band.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

46 Total market output value of RFID passive Internet of Things by Chinese domestic manufacturers (unit: 100 million yuan)

	2021	2022	2023	2024E	2025E	2026E	2027E	2028E
LF	9.9	9.9	9	9	9	9.3	9.2	9.5
HF	37	36	35	37	39	40	42	44
UHF	63	75	87	100	120	142	167	208

■UHF ■HF ■LF
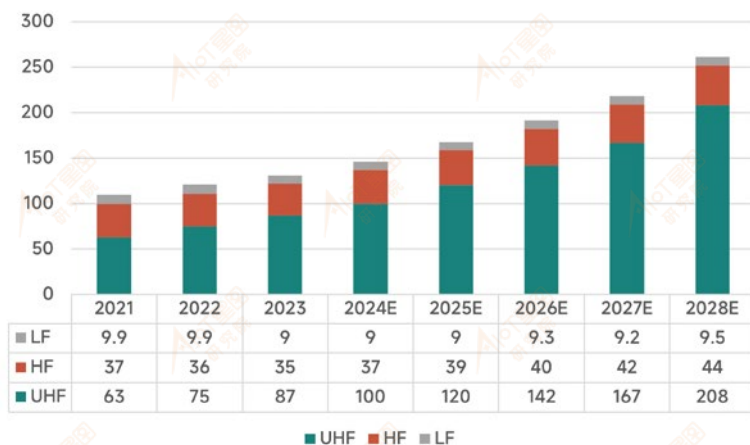
Data description:

1.In terms of output value share, the UHF band still has an obvious advantage, but the output value share of LF and HF bands is significantly higher than the share of shipments due to their higher average unit prices.

2.In 2023, the market output value of RFID passive Internet of Things by Chinese domestic manufacturers will be 12.1 billion yuan, forming a scale of tens of billions.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Part 7

Collection of excellent cases of RFID passive Internet of Things industry

⬤ Checkpoint

Sharing of industry applications of Checkpoint RFID tags

Development trend and application of RFID tags

The 2023 "White Paper on China's RFID Passive Internet of Things Industry" shows that RFID tags are growing because of policy promotion and market growth. In 2022, the global shipment of UHF RFID tags has reached 36 billion pieces, and the market is expected to reach 80 billion by 2027. In the application sector, supply chain and general merchandise become the tie 1 RFID application are together with apparel and footwear. The change is due to the significant demand of e-commerce and RFID's further penetration in supermarkets like Walmart for example.

The application of RFID labels has entered an unprecedented period of fast development. The quality and performance of the RFID label is crucial for RFID solution deployment and guarantees a better return on investment

As a global leader in RFID solutions, Checkpoint Systems is one of the only companies that own every stage of your RFID journey, from inlay design to hardware configuration and testing to software development. We are the ARC certified RFID inlay manufacturer with strong capability of technology innovation and production capacity globally.. In recent years, Checkpoint is gradually expanding the innovative application of RFID labels into different vertical markets, helping customers to optimize operations, enhance security and elevate efficiency.

Industry application cases of Checkpoint RFID labels and solutions

1. Checkpoint RFID labels for apparel and footwear and general merchandise

Checkpoint Apparel Labeling Solutions (ALS) are a global branding and labeling partner for apparel retailers, brand owners, and manufacturers. We're with our customers from the creative concept stage to the finished garment. We have 22 ALS ticket centers around the world, providing unparalleled services to customers like the well-known French sports retailer the Spanish fast fashion giant, the Australian swimwear brand Speedo, and the North American fashion brand Urban Outfitters. Checkpoint also provides RFID supply chain solutions to LPP, a Polish retailer which has more than 2,200 stores in Europe.. LPP's global distribution centers and nearly 1,000 stores have deployed Checkpoint's RFID products, and have achieved a 3% sales growth and a stock-out rate of less than 0.5%.

In 2022, as Walmart expanded the application of RFID labels from apparel to general merchandise sector such as home, electronics, toys, sports and automotive products, Checkpoint became one of Walmart's designated suppliers of RFID labels. Checkpoint provides Walmart with nearly 20 label options, all of which have passed the corresponding ARC-W series, B1, O, R, Y2 and other categories of certification.

For the label application of footwear and general merchandise, in addition to high-quality products, Checkpoint also has the ability to process variable data, digital color management and calibration solutions, and a global unified order system to achieve more accurate and higher standard project support.

RFID labels not only carry data information for enterprises, but also enhance brand image and global marketing compliance. Checkpoint's CheckNet global label order system is the solution that has been adopted by global retailers. The platform is developed, designed and maintained by Checkpoint, which guarantees the operational transparency and information integrity of the project for customers. CheckNet guarantees unified management and real-time tracking of all orders in any region of the world, and always ensures that all variable data and reports are communicated and finalized based on a unified platform.

2.Checkpoint RFID labels for supply chain management

Project: Checkpoint deploys RFID supply chain solutions for a well-known global health care appliance brand to enhance sales channel and anti-cloning management.

Project scope: Customer's factories in China

Note: Due to the NDA between Checkpoint and the customer, we will not disclose customer name, project amount, KPI and other specific values.

Project requirements: Being a well-known health technology company, our customer provides best-in-class products and services for consumers worldwide. It manages thousands of distributors in China and requires an effective solution to manage their various sales channels, improve inventory accuracy and visibility across the supply chain.

Checkpoint Solution: Checkpoint provides RFID inlays to be applied at source in customer factories. The RFID label carries unique and traceable item information across the supply chain. By utilizing RFID hardware and software, the retailer can effectively track products sold and eliminate potential deceptive and fraudulent practices in their sales channels.

Considering the limited labeling space of small household appliances and the interference of metal and batteries, Checkpoint provides customer with Tulip M750 tags and Micro R6P tags with a slimmer appearance, which can be directly embedded in delicate parts such as electric toothbrushes and hair dryers.

Tulip M750
Project Custom Labels

Micro R6P

Triumph M750

After the deployment of RFID source tagging, Checkpoint also provides the customized software for the entire supply chain to track all products from factories to distribution centers and to different sales outlets at any stage. The system supports offline operation mode and has expandable functions to ensure that customers can obtain corresponding functional support at different stages of RFID deployment. During the trial run, more than 1.5 million RFID labels have been deployed. The software system processes more than 1.43 million data per month, helping customers reduce the cost, improve inventory accuracy, strengthen channel compliance management, and especially strengthen the control of cloned and anti-counterfeit products.

3.Checkpoint RFID labels for circular economy

Project: Checkpoint provides RFID labels and solutions for global fast food giant to manage reusable tableware

Project scope: The project is deployed in more than 1,200 restaurants of the brand in France

Note: Due to the NDA between Checkpoint and the client, customer information, project amount, KPI and other specific values cannot be disclosed.

Project requirements:

AGEC (Anti-Waste for a Circular Economy) is a new legislation that brings unique challenges for retailers, especially in the food industry. The target of the project is to reduce the use of disposable tableware and increase reusable tableware. The customer is looking for the solution to provide real-time visibility of its reusable tableware stock, delivering fast and efficient inventory management, optimising replenishment and ensuring the restaurant's stock lines are protected for long-term security and usability.

At the same time, Checkpoint provides the customer with RFID hardware equipment and customized software platform to support automatic inventory monitoring and tracking, including tableware type, real-time quantity, usage cycle (number of times it is washed) and replenishment needs, etc., to achieve up to 99% data accuracy, and can accurately locate the location of reusable tableware to prevent accidental loss. After the project was deployed, the data accuracy exceeded 99%, and the durability of the tag was stable and met expectations, whether in the customer's own cleaning center or outsourced cleaning factory.

Pali Inlay

Vortex Inlay

About Checkpoint RFID Label

As part of CCL Industries, Checkpoint Systems has a proven track record of successful RFID implementations. We are one of the only companies that own every stage of your RFID journey, from inlay design to hardware configuration and testing to software development.

With over 50 years of industry experience, we collaborate closely with clients that catalyze growth and define success. Our products and solutions are widely adapted in apparel, general merchandise, fresh food, H&B and logistics & supply chain. Through cutting-edge RFID technologies, we optimize operations, enhance security, and elevate efficiency.

The RFID consumables portfolio is optimized for use with Checkpoint's merchandise visibility solution and is compatible with our RFID as EAS for loss prevention. Checkpoint RFID labels leverage open-standards technology to deliver benefits for both inventory accuracy and loss prevention with a single tag.

Checkpoint's Strategy of Sustainability

At Checkpoint Systems, we recognize that businesses have an important role to play in conserving the planet's precious natural resources and safeguarding the environment for future generations. Far more than just our physical products, sustainability extends to our locations, our people and our customers. Our facilities are built to the latest standards and are audited and accredited with multiple ethical and environmental accreditations & standards.

Our production facilities in China and around the world are committed to the highest standards of business ethics and environmental protection measures, and have passed certifications including ISO, GRS, SEDEX, BSCI, FSC, HIGG, etc.

At the same time, Checkpoint relies on product innovation to reduce the use of plastics and promote the leading concept of environmentally friendly labels and recyclable labels. There is currently no global standard for the recycling of RFID labels But as early as 2022, Checkpoint worked with a third-party company to test Checkpoint's labels on different packaging materials. The test showed that the comprehensive recyclability rate exceeded 94%. Sustainability has become increasingly important as the European market has taken the lead in promulgating and implementing the EU Packaging and Packaging Waste Regulation (PPWR).

Solution Provider: Dascom Group

Background ▼

Warehousing logistics refers to integrated logistics services based on logistics management systems from warehouses to consumers. Warehousing logistics solution offers a range of services such as storage, transportation, distribution, and packaging, applicable across various industries. With the rapid growth of e-commerce and the expansion of the logistics sector, warehousing logistics solution has become increasingly prominent in the market, gaining significant attention. A warehousing logistics solution provides customers with storage, distribution, and management services within the logistics process, which effectively addresses customers' logistical challenges, improves logistic efficiency, reduces costs, and represents a highly efficient business pattern.

In the future, warehousing logistics solution will focus more on digitalization, intelligence, and automation to enhance logistics efficiency and improve the user experience. Additionally, Such solution will leverage technologies such as RFID, big data digital twins to drive innovation and upgrades in the logistics industry.

Requirements ▼

The modern logistics industry is becoming increasingly mature, and the advantages of warehousing logistics solution in vertical markets are becoming more prominent. More and more enterprises and National Sectors are adopting intelligent warehousing logistics solution such as B2B, B2A logistics distribution, infrastructure materials, medical supplies, and relief materials. In addition to improving supply chain efficiency and reducing logistics costs, this solution allows enterprise to focus more on their core business and enhance their competitiveness. In a word, warehousing logistics services are an excellent choice for catching up market changes and optimizing logistics processes.

Warehousing Logistic Demand

Efficient Stocktaking | Tracing | Fine-tuned Management | Digital Twin | Cost Reduction and Efficiency Improvement | Intelligent
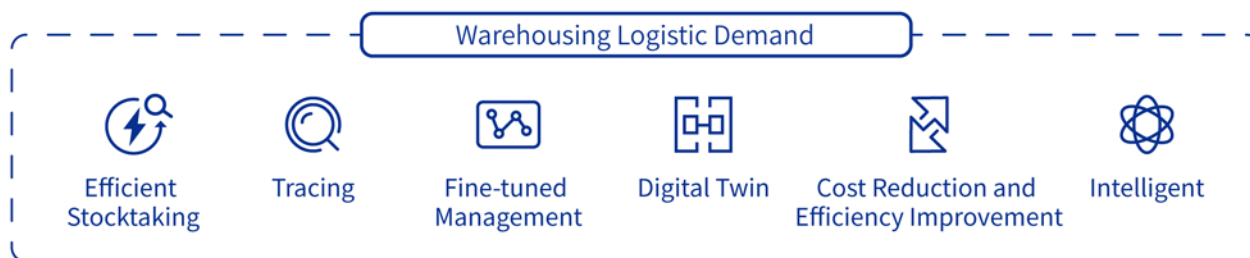
The importance of warehousing logistics for enterprise cannot be overlooked. On one hand, it optimizes inventory management, reduces waste of stock through fine-tuned management, improves inventory turnover and capital efficiency. On the other hand, it boosts logistics efficiency and delivery times, enabling enterprise to better serve their customers. In the view of long-term, high-quality warehousing logistics services influence customer perception and trust and enhance the effectiveness of customer relationship management.

Completed Solution Process ▼

Making and Labeling → In & Out of Warehousing → Goods Related Location → Stocktaking → Digital Twin

1. Making and Labeling:

In warehousing logistics, the article labels are typically carton labels or delivery receipt. Both labels can be replaced with RFID tags. The RFID printer print the necessary information and write data to the RFID tags. Also an RFID labeling engine can be used in the automatic production line.

2. In & Out of Warehousing:

In & Out of Warehousing is an essential sector in the daily operations of all warehouses and enterprises. Different solution is implemented different application based on the specific demand and the level of investment.

Small-sized Enterprise or Clothes Industry: PDA for acquiring the data and verifying

Entrance and Exit (Sporadic): access control, or ceiling collector

Entrance and Exit (Periodic or large-scale): channel machine and room

3. Goods Related Location:

Warehousing is generally divided into vertical warehouses and flat warehouses. In vertical warehouses, good location is managed by specific slots, and there are numbers on the shelves to track item location. In flat warehouses, good location is managed by designated areas.

Vertical warehouse: Forklift reader plus RFID tags
Shelf: Multi-channel reader or PDA plus labels on the shelf
Flat warehouse: PDA or forklift for binding goods to area tags

4. Stocktaking:

Stocktaking is essential for sorting out the inventory and recognizing goods period, ensuring accurate data for practices like "first-in, first-out". In large warehouses, static stocktaking is impractical, as inbound and outbound operations continue during the stocktaking period, which takes larger human resource and material in warehouse stocktaking and will result in discrepancies between counted data and actual stock.

In general, there are 4 stocktaking methods according to the scenario:

PDA:
Scenario: stocktaking quantity is small and the good is not metal, i.e carton label or there is gap inside the carton.

Stocktaking Cart: Scenarios: the goods are placed regularly and the warehouse is small with manual management.

Stocktaking Robot: Scenarios: the goods are placed regularly and warehouse is larger, or warehouse without manual management.
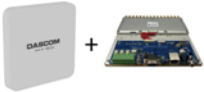
Fixed Antenna: Scenarios: the goods are placed regularly and the warehouse is small, also the fixed area is managed by backstage.

The value of RFID technology in warehousing ▼

Making and Labeling

Items are no longer inanimate but have become IoT-enabled, with traceable information accessible at any time.

In & Out of Warehouse

40 times efficiency improved than traditional barcode scanning method.

Goods Related Location

it reduces the manual error.

Stocktaking

100 times efficiency improved of similar vertical management.

Digital Twins

More intuitive control over dynamic real-time data in warehouse or logistics processes.

Kiloway Technology

RFID: connect the world invisiblly

X-RFID® chip, being for digital world & smart life

Nowadays, UHF RFID tags are replacing barcodes and becoming the main tool of identification in the digital world. It can identify thousands of items in seconds wirelessly, bringing the future digital world and smart life within arm's reach.

With the enhancement of computing power on cloud platforms, item identification now only requires an ID number to identify. It no longer needs terminals to store business information. RFID only carries the ID number without data conversion, offering higher recognition efficiency for identification. "Cloud + terminal" is expected a more efficient model of the IoT in the future. For applications that only requires one-time programming, Kiloway has launched highly reliable OTP RFID tag chips based on our patented X-RFID® technology, with shipments over 2 billion pieces.

In the application of RFID, when the RFID tag surface is printed, the data in its chip cannot be rewritten to maintain data consistency; when the RFID tag surface is not printed but only embedded in an item or package, the RFID tag chip shows the ID information, and it no longer needs to be repeatedly written and rewritten, which facilitates the connection and processing of the smart application system in every business link. If all links need to be written into the chip, it will increase the investment in the hardware system and the risk of inaccurate business operations. Therefore, we believe that advanced application systems no longer need the data erasable in RFID chips. Kiloway's X-RFID® technology route aims to achieve both lower costs and excellent performance.

I. One-Time Programming (OTP) Chips

Based on original XLPM memory, Kiloway has launched the X series chips featuring OTP. It has excellent characteristics, including high performance, high efficiency, high reliability, and high yield, coupled with low cost, and has extremely strong environmental adaptability.

▪**Single-port chip KX2005X-S/512/B: applicated in apparel, logistics, medicine, archives, asset management, etc.**

▪**Dual-port chip KX2005XG-B/544: applicated in air luggage sorting, asset management, medicine, food management, etc.**

RFID tags are generally used for read-out operations such as identification and group reading (inventory). OTP RFID tags can meet most of the demands of the entire business process, making the application of RFID tags becoming more simplified and easier to use. Repeated programming has basically phrased out of the market.

Kiloway's X series chips have been shipped over 2 billion pieces, bringing customers the advantages of low cost, high reliability, high stability, high sensitivity and high yield. Kiloway's X series chips provide different capacities of User area to meet the needs of multiple data writing. Data can be written to the User area through the append write mode. It needs to be written in segments over multiple times if the data capacity exceeds 512 bits.

The X series chips are compatible with mainstream handheld devices, RFID printers, airline luggage printers, and clothing labels high-speed coding equipments, and can automatically calibrate various labels packaged with X series chips. The coding yield is more than 99% (Zebra printers can print Kiloway chip labels by manual calibration, contact Kiloway for support). The bit-by-bit read verification and multiple writing mechanism ensure the correctness of the data and increase the writing time. If the coding is incomplete or not written, just rewrite it once.

Tags in clothing labels have achieved high-speed coding on POINT-LINK, CLS, ZHILIAN TECHNOLOGY and others equipment. By fine-tuning the equipment parameters according to the characteristics of the Kiloway chip, the coding rejection rate can be 3‰ to 5‰.

II.Read-Only Chips

▪ **ONLY 1/2: For disposable low-cost applications, such as apparel, retail, and logistics**

For massive disposable applications, the cost of electronic tags is a critical factor in a program. Ideally, tags should be discarded after turnover similar to barcodes, The read-only chips simplify the complexity of RFID Based on the original RF-o-ID technology, it only provides a unique S-EPC code as the item code. It does not require data writing after factory curing. It can be used after being bound to the product, avoiding the complexity and high cost of multiple writing. The chip adopts a read-only mode without writing. It reduces the cost by 40% and improves the efficiency by 80%, achieving both lower costs and excellent performance.

The cost of the read-only chip is low enough, only carrying a unique S-EPC code. It can be seamlessly applied to existing barcodes businesses. It achieves one code for one item (it can represent about $3.4*10^{38}$ items) and has group reading function, greatly improving the efficiency of the logistics system. It can quickly replace the existing barcodes system, or coexist with the existing barcodes, verifying and complementing each other.

In actual use, customers may still need to print data on the surface of the tag. The read-only tag does not require the writing function of the RFID printer, but only printing and RFID reading functions of an ordinary printer, improving speed and yield. If it is incompatible with some RFID printers and unable to calibrate and locate, it can be solved by simply upgrading the printer's firmware. Many mainstream RFID printer manufacturers have cooperated with Kiloway to solve this problem. If you have any other questions, please contact Kiloway for support. Kiloway's partners can provide

customers with low-cost "ordinary printer + RFID printing assistant" hardware solutions.

In applications, read-only chips can not only be used for logistics and supply chain management, but also widely used in asset management, retail, medical care and other fields. Minimalist design and low cost of the ONLY chips enable customers a more efficient and economical solution.

III . Functional Chips

1.KX2005X-BR Anti-Medical Radiation Chip

Kiloway's anti-medical radiation chip has passed irradiation tests conducted by two national-level laboratories in China, and its irradiation tolerance is significantly lower than the standards set by the National Health Commission of China. It is designed for the medical and food safety applications to ensure stable performance in high-irradiation environments.

2.KX2005X-BT Passive On-Off Detection Chip

Kiloway's passive on-off detection chip can detect the on-off status between two TD Pads. This function does not require specific instructions or read-write devices, and can be easily implemented using the Inventory and Read instructions in the EPC protocol, without specific instructions and read-write devices.

In business operations, please ensure the correctness of each inventory before TD detection. Only when the tag is correctly "Inventory", the subsequent Read instructions are meaningful, and the TD detection results will be accurate. Otherwise there may be a misjudgment. It is suggested to change the TD status after the tag is powered off, as disconnecting the TD Pad and then re-powering on for detection. When powered on, The chip will not update the TD status if it disconnects from the TD Pad. It only return the last status result, causing a misjudgment.

To obtain stable TD status results, it is suggested that the resistance between TD Pads does not exceed 0.5MΩ, and the distance between the reader and the tag does not exceed 50cm.

3.KX2005X-BL Passive Lighting Chip

KX2005X-BL is a passive, battery-free lighting chip that can illuminate LED lamp beeds on various types of tags, such as anti-metal tags and paper tags. By using a handheld device, it can be lit over long distance, including single group lighting and continuous lighting modes. On paper tags, LED lamp and chips are inverted packaged with the same process and equipment. It greatly reduces the cost of lighting tags, and also improves the production efficiency of tags. When receiving the reader signal, tags will generate voltage between the LED Pad and GND to light the LED lamp, without an additional power supply. It can accurately identify individual item and enhance the efficiency and visibility. It is particularly suitable for locating in spaces with a variety of items.

The passive lighting chip is highly compatible with existing common reading and writing devices. With common reading and writing devices, it can easily light single or multiple LED lamps. With a customized reader (providing a continuous carrier signal), the LED can also enable continuously lighting. In order to ensure the brightness, it is necessary to maintain a suitable distance and sufficient power. The LED terminal voltage provided by the KX2005X-BL chip can reach up to 2.5V, and the most matching voltage is 1.8V. Please choose a suitable LED lamp for use.

KX2005X-BL provides a lower-cost and higher-efficiency solution, making it appealing to a wide range of industries.

Innovative and excellent X-RFID® chip series provide a more reliable and efficient solution for IoT applications, meeting the diverse needs of customers from a wide range of industries.

SENSE Technology

SENSE-HW100 ITC Equipment Intelligent Cloud Warehouse Management System Project Case

1. Introduction to Successful Cases

This successful case is a set of RFID digital warehouse management systems for well-known domestic companies. It uses SENSE Technology's independently innovative RFID technology and AI algorithm technology and customizes electronic tags for wholly-owned products for customers, realizing unattended intelligent equipment warehouse management systems. It uses RFID automatic identification technology to achieve automated operations through the storage, inventory, and circulation of electronic parts in the warehouse.

At present, the traditional material management model of most companies generally has huge material inventory, material inventory and difficulty in tracking, resulting in low inventory material turnover efficiency of corporate assets and equipment, high labor costs, and high inventory loss costs. Through the introduction of RFID technology, after seamless docking with customer business systems, coordinate the operation of each link, ensure timely and accurate inbound and outbound operations and real-time transparent inventory control operations, reasonably allocate warehouse resources, optimize warehouse layout and improve warehouse operation level, improve storage service quality, save labor and inventory space, and reduce operating costs

Customer requirements: Without losing the space of the existing warehouse, the whole box of finished products and unpacked single-item electronic materials are fully automatically counted, in and out of the warehouse, and automatically find items.

In the area where the RFID management system is located, the real-time performance is required to be 100%, the inventory accuracy is 99.9%, and the accuracy of finding the location of the item area is 95%.

Project indicators: The original packaging materials on the multi-layer shelves in the warehouse are fully automatically counted, with an inventory accuracy of 99.9% and an inventory accuracy of 99.9% for goods entering and leaving the warehouse; for electronic materials containing metal materials, the inventory rate is 99.9% while maintaining the original storage space and storage volume of each shelf.
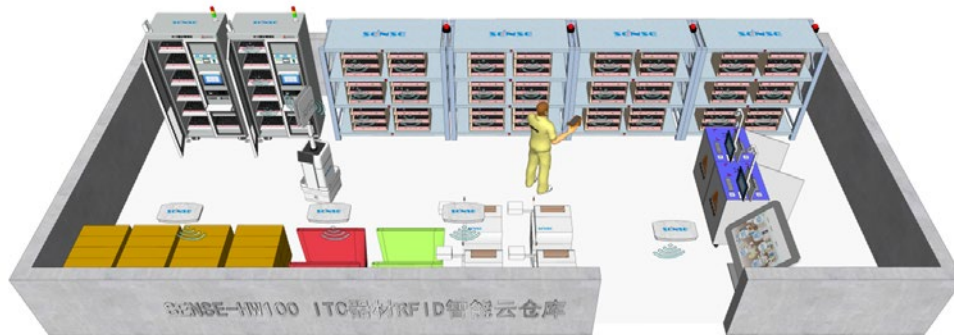
SENSE-HW100 ITC equipment intelligent cloud warehouse management system deployment diagram

2. Project goals

· Achieve 99.999% accurate automatic identification of RFID tags;

· Real-time inventory counting and monitoring of more than 1 million electronic equipment assets in more than 200 warehouses with a total area of more than 50,000 square meters;

· Achieve accurate shelf-level search and positioning of all warehouse assets;

· Achieve unattended, non-sensing access operation, real-time automatic inventory counting and search functions;

· A variety of special RFID tags patented by Sincere Technology achieve the best matching performance between RFID and items, solving the historical problem of electronic equipment identification and inventory management;

· Sincere Technology's patented smart shelf embedded RFID equipment and algorithms achieve maximum utilization of warehouse space and beautiful appearance;

· Greatly improve the customer's warehousing operation efficiency and management level;

· Achieve a full warehouse coverage RFID digital management scenario for customers.

3. Description of the technical innovation of Xinshi Technology in this project

The system product of this project is to seamlessly embed the RFID reading and writing system into the existing shelves of the warehouse in a modular manner, providing enterprises with a space-efficient and intelligent RFID warehousing solution. Combined with Xinshi Technology's advanced intelligent RFID antenna array and AI positioning algorithm technology and MQTT mode industrial high-reliability data exchange technology, the reading range of RFID devices in all warehouse areas is effectively read and controlled, ensuring more than 99.999% accurate automatic identification of RFID capabilities (no misreading, no missed reading, no cross-reading). It reliably realizes the management process of real-time RFID collection, tracking, error prevention, monitoring and control of warehouse data from more than 200 warehouses from warehousing, shelving, inventory, finding goods, and outbound delivery, real-time automatic recording, automatic data transmission, etc. Improve the efficiency of warehouse optimization inventory, achieve rapid traceability, and make the product transparent and visual automatic management.

4. Description of the economic value achieved by the successful application of the project

Through the actual operation and use of the customer for nearly a year, the successful application of the "SENSE-HW100 ITC Equipment Intelligent Cloud Warehouse Management System" has greatly improved the daily work efficiency of the warehouse for the customer and greatly reduced the error rate. At the same time, it has achieved the economic value of reducing costs and improving efficiency for the customer. According to preliminary statistics: after the real-time automatic inventory system was launched, the number of managers in each warehouse was reduced to 2, the quarterly inventory was reduced by 15 man-days, and the annual inventory was reduced by 28-30 man-days; the inventory loss ratio was reduced by more than 98%.

Zhongshifa

Zhongshifa's sharing on RFID smart retail solutions

1. Project background

1.1 Necessity and feasibility

The scale of domestic and foreign retail markets has been increasing year by year. Consumers in the retail industry are no longer concerned with product quality, but are gradually showing demand for personalized products and services and experience environments. The development trend of the retail industry also reflects the characteristics of chain, branding and digital intelligence. RFID has become one of the main application technologies for the transformation of the retail industry with its penetrating, group-readable identification, and data storage.

2. RFID retail solutions

2.1 Solution overview

SRS AI smart retail is an RFID retail overall solution that integrates smart retail, smart warehousing, and store management. By attaching RFID tags to the goods in retail stores to give them a unique ID, combined with hardware and software, it can realize the overall linkage of people, goods, and venues, break through the barriers between roles, and realize the digital transformation and upgrading of the traditional retail industry. At present, Zhongshifa has applied it through its own channels.

Warehouse management

Supplier management
In and out of storage and inventory
Quickly find goods

Application scenarios

Store management

Retail management

Automatic settlement
Online delivery
Account management

Warehouse management

Purchase inbound — Material inventory — Purchase outbound

Retail management:

Receipt verification — Store shelves — Store inventory — Cashier settlement — Access control system — Store returns

Commission split

2.2 Application scenario construction

2.2.1 Warehouse management

Supplier management: The supplier management module provides a comprehensive solution that allows retailers to effectively manage all links in the goods supply chain. This module covers key functions such as supplier classification, commodity expiration monitoring, and accurate time tracking of arrival, thereby helping retailers to minimize product losses caused by supply chain problems and ensure efficient operation and cost control of the supply chain.

Inbound and outbound inventory: In the store warehouse, employees can use handheld terminals PDA to complete batch reading and warehousing operations of goods, and synchronize mobile terminals to monitor inventory data in real time to ensure the accuracy of the data, which not only improves the speed and efficiency of the inventory process, but also greatly shortens the time required for inventory, thereby saving a lot of time costs for the entire application scenario. This workflow upgrade improves inventory efficiency, making each inventory a quick and accurate business activity,

which can effectively ensure the accuracy and efficiency of inventory management.

Quickly find goods: For goods that need to be handled separately, they can be quickly located by accurately measuring signal strength to ensure that the goods are not misclassified or missed. It greatly improves the efficiency and accuracy of goods management.

2.2.2 Retail Management

Self-service checkout: It can make consumers' shopping experience more convenient. When customers choose the goods, they only need to put the selected goods into the sensing area, and the system can quickly identify and complete the corresponding goods settlement work without manual intervention.

Online delivery: The retail online applet mall connects to the distributor to ensure that the goods can be delivered to customers quickly and accurately. Users can choose self-pickup or delivery service with just one click and enjoy a convenient shopping experience.

Account management: The account management system is compatible with multiple payment platforms and multiple transaction channels, and realizes the settlement of commissions on the same day. Through the automated processing process, the cumbersome manual accounting steps are greatly reduced, which effectively improves the convenience and security of fund management.

2.2.3 Store management

Store anti-theft: If goods are taken out of the channel door without completing the settlement, the system will immediately activate the alarm function after detection and identification. This measure is intended to prevent goods from being illegally transferred or lost, and ensure the safety and compliance of store management.

Price tag management: ESL shelf labels replace traditional paper labels and update the latest information related to products in real time, thus presenting multi-dimensional and digital application scenarios on the shelves, enhancing the user experience and making the shopping process more intuitive and convenient.

2.3 Solution value

2.3.1 Application value

(1) Improve the operation level and efficiency of retailer

Multi-scenario applications can comprehensively improve the level of supply chain management, sales management, and store management of retailers.

(2) Promote the upgrading of the retail industry chain from the application end

Through terminal applications, promote the pre-positioning of RFID tags, thereby driving the upgrading and transformation of the entire industry chain.

2.3.2 Business value

(1) Provide data insights for AI+ sales conversion

The data-driven retail model has become a major trend in the modern retail industry, helping merchants to better understand market dynamics and optimize inventory management. Retailers can understand customer behavior patterns and consumption trends, formulate more accurate marketing strategies, improve the effectiveness and conversion rate of promotional activities, and provide customers with a more personalized and satisfactory shopping experience.

(2) Providing retailers with differentiated competitive advantages

Scenario-based experience is not just a simple sales environment, it is a deep reflection of brand value and provides retailers with a unique competitive advantage. Through carefully designed shopping scenes and interactive experiences, retailers can create an atmosphere that attracts customers and motivates them to buy. This unique retail experience enables the brand to establish a distinctive image in the minds of consumers, thereby occupying a favorable position in the highly competitive market and winning the favor and loyalty of consumers.

About Zhongshifa

Zhongshifa is a national high-tech enterprise focusing on the research and development, production, Internet of Things technology development and overall solutions of RFID smart tags, and a "specialized, refined and innovative" enterprise in Guangdong Province. The company's main products are high-frequency and ultra-high-frequency radio frequency identification labels and tags, which are now widely used in healthcare, logistics, supply chain, jewelry, aviation, clothing, new retail, asset management, anti-counterfeiting identification and industrial manufacturing. After years of industry experience, Zhongshifa has established a complete RFID product design and production system. We will spare no effort to build a national RFID technology service cluster, provide a practical platform for RFID industry technology exchanges, and strive to become a leading enterprise in the RFID industry.

Pragmatic Semiconductor

Introducing Pragmatic Semiconductor

Pragmatic is revolutionising semiconductor technology design and fabrication, redefining the parameters of connectivity and fuelling sustainable cross-sector innovation. Our unique, flexible integrated circuits (FlexICs) deliver low-cost, low-carbon intelligence at scale to fuel the AI enabled Internet of Everything. The Pragmatic FlexIC Foundry delivers rapid, high-volume fabrication with a high level of customisation, taking design from tape-out to delivery in just four weeks.

The flexible future of IoT connectivity

Digital transformation is impacting every facet of business, industry and our everyday lives, offering increasingly levels of connectivity and personalisation, enabling exciting new capabilities, efficiencies and experiences. In the consumer space, product authentication and consumer engagement models are being deployed at scale. In the healthcare sector, wearable health monitors and widescale testing are proliferating. Industry 4.0 solutions are gaining traction everywhere, from logistics to smart manufacturing and supply chain optimisation.

AI-enabled IoT applications present a huge market opportunity across every sector. Gartner estimates that opportunity to be $821 billion USD in 2025 across IoT endpoint electronics, communications services, edge device security, application software, infrastructure software and IT services.

Data is core to fuelling digital transformation, with billions of connected devices transforming decision making. Semiconductors have a vital role to play in creating that data. Simply put, there is no digital transformation without semiconductors. They are the lifeblood of the IoT and the beating heart of every connected device, generating the big data to feed AI systems. And these systems bring the insights we need to tackle complex, global problems.

Addressing the biggest issues

Food waste is a big problem: an incredible 25-30% of global greenhouse gas emissions come from food systems, yet over a third of all food produced is wasted – both within retail environments and in consumers' homes.

During transit from farm to fork, fresh food is vulnerable to environmental fluctuations that can impact quality and freshness. Produce suppliers face fines if fresh foods degrade ahead of use-by dates, so these dates tend to be conservative. This can result in disposal of food that is still good to eat.

And what about healthcare?

Fluctuations in temperature can cause vaccines to degrade, impacting efficacy. Around the world, millions of vaccine doses are wasted annually due to handling and storage challenges. Imagine how many more people could be vaccinated if we could reduce or even remove that wastage.

So here's an idea: let's make all packaging smart. Imagine the insights we could get from all that data! We could detect changes in the freshness of foods and use that information to activate a dynamic supply chain or reactive pricing.

We could provide vaccines with a unique, secure identity to assist with traceability and real-time stock management. We could also use smart temperature sensors to ensure that cold chain conditions are maintained.

So why don't we just do it?

The barriers to ubiquitous intelligence

There are several hurdles to overcome before we can achieve ubiquitous connectivity and intelligence. Firstly, cost: it's expensive to add a silicon chip to each and every plastic wrapper or carton. The long lead times and high costs associated with standard chip design mean that it is best reserved for creating complex, hi-spec chips in applications that demand commensurately high performance.

Second, there simply aren't enough fabs in the world producing the right kind of legacy chip.

Third, the environmental impact would be prohibitive. Current production of silicon-based semiconductors uses vast amounts of water and energy, and up to 30 different process gases, many with considerably higher global warming potential than CO_2.

But there is an alternative. It won't replace silicon, but it will work alongside silicon – and it's highly customisable, low cost and has a lower carbon footprint. That alternative is https://www.pragmaticsemi.com/flexible-ics – flexible integrated circuits.

Achieving ubiquitous connectivity

FlexICs are ultra-thin and can be shaped to a millimetre-range radius of curvature without impairing functionality. This enables novel solutions that are simply not possible with conventional semiconductors. They also bring a number of other benefits:

·Rapid, low-cost customisation

The simplified production process reduces non-recurring engineering costs, and allows end-to-end production of FlexICs at a single site. As a result, production – and customisation – is significantly faster. In fact, the Pragmatic https://www.pragmaticsemi.com/foundry takes designs from tape-out to delivery in around four weeks, so customers can get to market quicker.

·High-capacity, localised production

Simplified production also results in smaller, more cost-effective fabs. These 'mini fabs' – capable of producing billions of chips per year – can be deployed almost anywhere, thanks to their concentrated footprint. This can improve the resilience of domestic supply chains, and onshore semiconductor production at a fraction of the cost, time and energy consumption of standard semiconductor fabs.

·Reduced environmental impact

The unique fabrication production process also omits many of the resource-intensive, high-temperature stages of silicon semiconductor manufacturing, using less water and energy, and significantly fewer harmful chemicals. This results in a significantly smaller carbon footprint.

Contributing to a better world

So, how can FlexICs help to solve global problems? The answer is by providing low-cost, low-carbon scalable connectivity. Because scalability is critical if we really want to move the needle.

At Pragmatic, we're already part of a two-year, multi-million pound project called https://www.pragmaticsemi.com/case-studies/trace – that aims to demonstrate how smart technologies can enable reusable packaging at scale, beginning with smart, reusable packaging for food and beverage retail.

We're also part of https://www.pragmaticsemi.com/case-studies/secqual – which has seen the development of a smart NFC sensing solution, based on FlexICs, to measure in-pack conditions of fresh meat products.

This low-cost technology makes it viable to add intelligence to high-volume products, making insights available to retailers and consumers, increasing widespread adoption and positively impacting the fight against food waste.

In healthcare, we're developing a low-cost, flexible temperature sensor as part of https://susfeproject.eu/ , a sustainable flexible electronics project funded by the European Union's Horizon 2020 research and innovation programme.

Lightweight, flexible patches, equipped with flexible sensors, are a low-cost and efficient way to alert clinicians to signs of deterioration via moisture/leak detection or changes in temperature, pressure or pH. But this same functionality could also be used as a low-cost way to ensure cold chain integrity.

Accelerating the shift from IoT to IoE

These applications are just the tip of the iceberg. As we move from the Internet of Things to the Internet of Everything, ultra-thin, low-cost chips such as FlexICs may prove crucial for providing intelligent data and driving efficiency at a low environmental overhead.

FlexICs will not replace silicon chips; they'll complement them. But the shift from the IoT to the IoE cannot happen on silicon alone due to constraints around cost, form factor, durability or sustainability. FlexICs represent a new paradigm, and an opportunity to sustainably deliver smart functionality wherever it's needed.

Connect, sense, compute: FlexIC applications
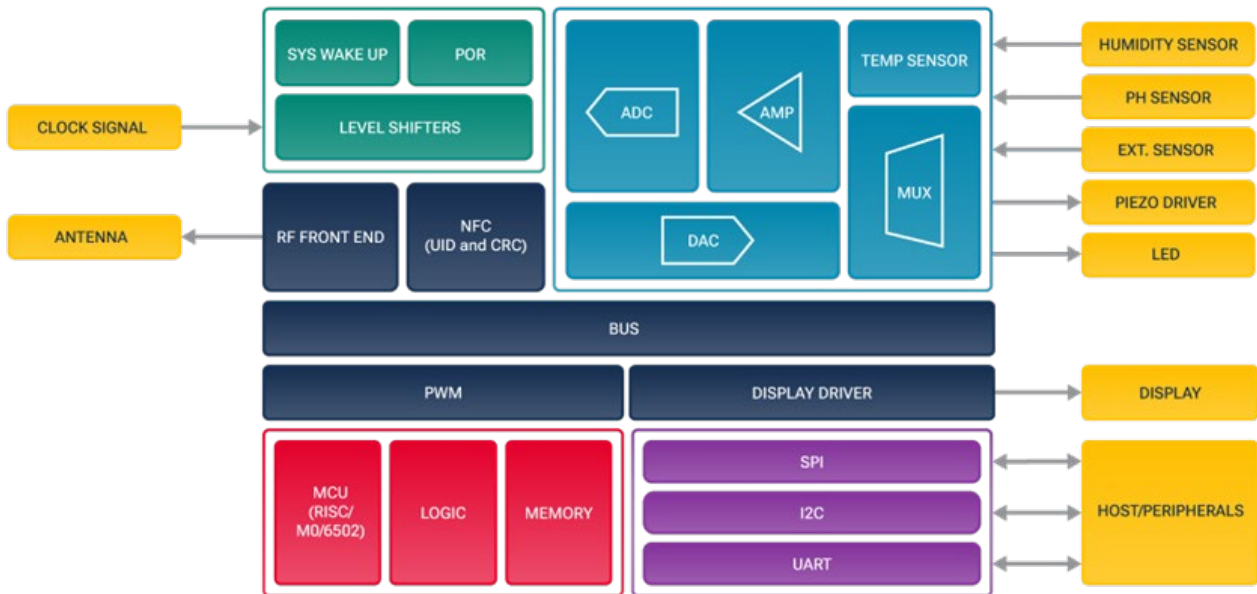
Retail/FMCG

Digital transformation is impacting all aspects of FMCG as organisations strive for growth amid intense competition and changing market needs. FlexICs provide the low-cost, item-level intelligence necessary for deployment at scale, with a low carbon footprint to minimise environmental impact.

·Dynamic pricing

Manage and adjust prices across multiple locations with electronic shelf labels (ESLs) making it quick and easy to implement discounts, and special offers. ESLs provide product information updates, ensuring accuracy and consistency, reducing the risk of customer dissatisfaction.

·Consumer engagement

Transform customer relationships with smooth, interactive engagement – accessible with a single tap of a smartphone. Discreet and protected, embedded FlexICs give instant access to dynamic, personalised content, helping to drive loyalty and make every touchpoint a richer experience.

·Product authentication

Enabling secure verification of products with a simple tap, FlexICs ensure authenticity, combat counterfeiting, and build consumer trust. Embedded into products or packaging, their unique ID cannot be replicated or replaced, and their ultra-thin form factor provides low-profile protection that can't easily be damaged in transit.

·Tamper detection

Strengthen brand trust and build consumer confidence with FlexIC tamper-detect functionality. One-tap verification ensures product integrity, providing real-time assurance of authenticity and safety. Accessible and effective for a wide range of products, their low carbon footprint makes them ideal for use in high-value goods.

Healthcare

NFC has an important role to play in next-generation healthcare. Wearable healthcare devices such as smartwatches, fitness trackers, and medical alert devices offer a seamless way to monitor and manage health. FlexICs' low cost and innovative form factor open new use cases and enable system miniaturisation, for more compact, efficient designs, while increasing user comfort.

·Detection of cardiovascular disease

Detect atrial fibrillation – heartbeat irregularities that may foreshadow more serious coronary events – quickly and easily with FlexIC-based smart patches. Cost-effective and comfortable to wear, they could help to improve outcomes in at-risk patients.

·Disease prediction

Smart patches could also be used to predict other diseases. A recent study pioneered a non-invasive technique for the early detection of breast cancer from fingertip smears, for example. A FlexIC-based smart patch detecting skin pH (acidity/alkalinity) levels could provide a comfortable, low-cost, patient-friendly detection solution.

·**Wound monitoring**

Smart patches also provide a low-cost and efficient way to alerts clinicians to signs of deterioration via moisture/leak detection or changes in temperature, pressure or pH, allowing real-time, point-of-care assessment of chronic wounds.

·**Rapid information sharing**

NFC-based wearables can be used in emergency situations to quickly share critical medical information with first responders, ensuring that patients receive appropriate care even when unable to communicate.

Circular economy

Increasing concern over the environmental impact of linear, 'take-make-waste' manufacturing models is ushering in an era of transformational change, and a shift towards a circular economy focused on better use of resources and materials.

Low-cost FlexICs underpin scalable circular solutions, bringing item-level intelligence, driving operational efficiency and inspiring new ways to reduce, reuse and recycle.

·**Reducing food waste**

Smart packaging can help tackle the 930 million tonnes of food that goes to waste each year. Sensors within packaging can detect the volatile organic compounds that indicate deterioration in food, flagging that action is required to preventing spoilage.

·**Encouraging packaging reuse**

Standard, 'no-tech' packaging solutions work well on a small scale but typically require human intervention, which can be a time-suck in busy retail environments. Smart packaging encourages automation, accuracy and efficiency.

·**Digital Product Passport**

Digital Product Passports (DPP) gather and store data on a product and its supply chain, aiming to increase its sustainability and circularity. FlexICs can increase the economic viability of DPP – even for low-cost items.

·**Accurate recycling**

Item-level traceability is not only valuable during the useful life of a product, but also at end-of-life. Being able to uniquely identify individual items of waste allows dramatically improved recycling outcomes.

Looking to the future

The applications for FlexICs are endless, offering new realms of opportunity and transformation.

Sensor swarms

As part of sensor swarms – clusters of interconnected sensors, working collaboratively to collect vast amounts of data in real-time – they could provide new, powerful ways to interact with our environment, enabling monitoring, detection and autonomous decision-making.

The applications of sensor swarms are as diverse as they are impactful. In environmental monitoring, they can track changes in climate, detect pollution levels, and even predict natural disasters with greater accuracy. In agriculture, they help optimise resource use, improve crop yields, and ensure sustainable farming practices. In urban settings, they contribute to the development of smart cities by enhancing traffic management, improving public safety, and optimising energy consumption. As these swarms become more sophisticated, their potential to revolutionise industries and improve quality of life grows exponentially.

Virtual Reality and Augmented Reality

In VR and AR applications, FlexICs can facilitate increasingly sophisticated remote immersive and interactive experiences, embedded into more lightweight, affordable, and user-friendly glasses and headsets, or even electronic skin.

Whether enhancing how we interact with the world by overlaying digital information onto our physical environment, or creating fully immersive environments, these advances will transform industries as diverse as healthcare, education, retail, and real estate. The potential for these technologies to enhance our understanding, interaction, and engagement is immense, providing hands-on experiences that are both safe and effective, or virtual workspaces will enable global collaboration in a local setting.

Biological computation

FlexICs may also have a role to play in biological computation, where microfluidics and lab-on-a-chip technologies implement operations that have historically required an entire laboratory. This innovation can make scientific research more efficient and cost-effective but can also democratise access to advanced diagnostic and analytical tools, potentially transforming healthcare and other fields worldwide.

The potential for innovation is boundless, inspiring us to push beyond current limitations and envision a future where everything is connected and anything is possible. The future is a canvas, waiting for your boldest, most creative ideas.

To find out more about FlexICs and what they can do for your use case, visit http://www.pragmaticsemi.com. For regular updates and announcements, sign up to our mailing list here: https://www.pragmaticsemi.com/mailing-list

Part 8

Introduction to China's Cellular Passive IoT Industry

This chapter introduces the cellular passive IoT in detail. Previously, the industry's special term for cellular passive IoT was "Passive IoT", but this year, 3GPP changed the special term for passive IoT to "Ambient IoT", abbreviated as "AIoT".

Although the 3GPP standard for cellular passive IoT has not yet been officially frozen, the industry's preliminary warm-up work is already in progress. We know that 5G has been commercially available for several years and is constantly evolving according to market demand. The next generation of 5G is called 5G-Advanced (commonly known as "5.5G" in the industry).

Cellular passive IoT technology is the next evolutionary version of 5.5G massive machine type communications (mMTC). Friends who are familiar with cellular communication technology should know that previously, the main technology for 5G's mMTC business direction was NB-IoT. However, after years of development and market integration, NB-IoT's application scenarios have gradually been fixed in meter reading scenarios, and a larger number of connection scenarios are not applicable. Therefore, in the future, cellular passive IoT will take on the main development of mMTC and achieve a connection scale of hundreds of billions.
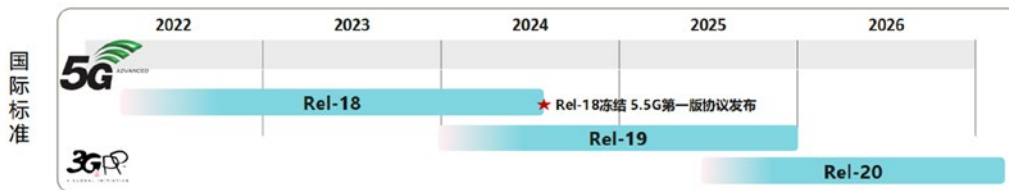
In the Rel-18 version of 3GPP, 5G-Advanced and the concept of cellular passive IoT have been proposed, but it is expected to mature and freeze the relevant standards in the next version Rel-19.

Tag type	Tag features	Tag cost	Power consumption	Coverage capability	Application scenarios
Category A Passive	· Scattering communication (RFID) · Energy storage capacity (uF capacitor) · No signal amplification capability · No independent signal capability	2-3Mao	1μW	MCL 72dB (LOS 20m /NLOS 13m)	toB: asset management, generation visualization toC: footwear, retail, logistics, food, medicine
Category B Semi-Passive	· Scattering communication (RFID) · Energy storage capacity (solar film) · Environmental energy collection capability (light, radio waves, etc.) · Signal amplification capability · No independent signal generation capability	6-8Mao	100μW	MCL 90dB (LOS 300m /NLOS 150m)	anti-metal, anti-liquid and other environmental requirements
Category C Active	· Energy storage capability · Environmental energy collection capability (light, radio waves, etc.) Signal amplification capability · Independent signal generation capability	Less than 2 yuan	500μW	MCL 124dB (LOS 2km /NLOS 500m)	ToB: transport container logistics tracking, etc. ToG: city lifeline monitoring ToC: search for people and things, etc.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

According to the current plan, the labels of cellular passive IoT are classified, and three categories of labels are defined according to different scenario characteristics and different cost requirements:

In summary, even the most expensive Class C label is much cheaper than other technical products on the market. Only extremely low cost can release all connection potential.

In the previous cellular product line, high cost is a common problem, but after entering the era of cellular passive IoT, this stereotyped pattern will change.

According to the research data of this white paper, the global annual shipment of UHF RFID tags has exceeded 46 billion. With the data of HF and LF, this number exceeds 50 billion. The industry is still developing at a high speed, and the era of hundreds of billions of connections per year is not far away.

Part 9

Introduction to China's RFID Passive Internet of Things Listed Companie

Listed companies are the leaders of an industry. After years of development, a number of listed companies have emerged in the RFID industry. This white paper analyzes the operating conditions of listed companies and has a relatively important reference value for understanding the entire RFID industry.

47 Directory of Chinese publicly listed companies related to RFID and their operational data

Company	Stock Code	RFID related products business	2019		2020		2021		2022		2023	
			Revenue (million yuan)	Net profit (million yuan)	Revenue (million yuan)	Net profit (million yuan)	Revenue (million yuan)	Net profit (million yuan)	Revenue (million yuan)	Net profit (million yuan)	Revenue (million yuan)	Net profit (million yuan)
Invengo	002161	RFID chips, electronic tags, readers, handheld devices, RFID overall solutions	628.85	743.27	474.02	-437.43	492.25	-66.13	480.86	-30.02	601.27	28.12
XIAMEN XINDECO LTD	000701	RFID electronic tags, reading and writing equipment, RFID overall solutions	215.46	3.21	281.7	8.34	367.5	68.14	360.87	42.28	332.95	34.10
Newland	000997	Handheld terminals, smart terminals	6181.53	691.28	7062.87	454.49	7698.16	704.23	7369.90	-381.72	8249.52	1003.59
Aisino Co., Ltd.	600271	POS terminals, IC cards, financial self-service equipment	33904.08	1425.00	21812.69	1033.63	23515.54	1024.72	19314.08	1079	12574.82	202.72
Shandong New Beiyang Information Technology Co., Ltd.	002376	RFID readers, smart cabinets, etc.	2450.86	322.42	2395.93	185.09	2645.65	145.82	2276.54	-25.67	2189.65	19.26
Tungkong Inc.	002117	Smart cards, electronic tags, electronic tickets, etc.	1495.63	266.72	1180.86	163.33	1200.94	186.49	1064.97	134.61	1200.72	163.31
Shang Yang RFID Technology Yangzhou Co.,Ltd.	300078	RFID tags, RFID monitoring systems	444.14	35.41	318.93	37.71	233.12	22.13	264.21	47.11	207.71	22.08
Newcapec Electronics Co., Ltd.	300248	Smart cards, readers, reading and writing equipment	964.02	157.69	939.35	181.89	1016.66	161.00	1069.70	112.42	1061.40	107.51
Urovo Technology Co., Ltd.	300531	RFID handheld terminals	951.31	51.36	1159.29	119.18	1416.59	153.67	1411.37	156.36	1267.74	-166.84
Shanghai Fudan Microelectronics Group Co., Ltd.	688385	HF tag chips, reader chips, UHF tag/reader chips	1472.84	-162.61	1690.90	132.87	2577.26	514.47	3538.91	1076.84	3536.26	719.49
Giantec Semiconductor Corporation	688123	HF smart card chips	513.37	95.11	493.85	162.95	544.05	108.25	980.43	353.77	703.48	100.36
Beijing Silion Technology Corp.,Ltd.	836205	UHF RFID readers, RFID modules, handheld devices, smart tags and related supporting equipment	40.11	1.05	53.32	0.79	54.14	1.07	50.56	0.58	55.03	0.47
Xiamen Innov Photoelectric Technology Co., Ltd.	430525	Electronic tags and reading and writing equipment	89.6	12.97	106.54	15.97	114.39	21.04	106.08	17.86	104.21	17.37
ShenZhen Yuanmingjie Technology Co.,Ltd.	839786	RFID electronic tags and smart card production equipment and overall solutions	48.21	1.49	95.97	2.62	41.65	-5.51	39.55	0.91	72.58	11.02
Beijing Etag Technology Co., Ltd.	839733	RFID readers, electronic tags, solutions, system integration	22.68	5.02	19.22	3.85	16.12	0.97	17.44	-0.59	16.42	2.62
Huizhou Techzen I.O.T Science and Technology Co.,Ltd	837225	Clothing production management system and clothing intelligent suspension system	46.5	9.62	21.6	0.39	20.7	3.86	32.42	10.69	25.76	9.86
Ez Robot Corp	871912	Electronic tags, glass tube electronic tags, system integration	53.42	2.66	37.31	0.42	32.99	0.93	47.52	0.37	50.08	0.49

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

Part 10
More discussion on the RFID passive IoT industr

🔴 1. What are the implications of the domestic RFID supply chain being blocked by "ARC"?

There is a saying in the domestic RFID circle: domestic RFID tag manufacturers have suffered from "ARC" certification for a long time. This white paper discusses this topic.

First of all, what is ARC certification?

ARC certification refers to an RFID tag performance certification led by the University of Arkansas (Arkansas University), which is called Arkansas Radio Compliance (ARC) in the industry. Later, this laboratory moved to Auburn University (Auburn University). The background of this certification is: in the early UHF RFID market, retail companies such as Walmart and Macy's began to plan to use a large number of electronic tags. Due to their lack of understanding of UHF RFID technology, they commissioned Auburn University to formulate a set of standard rules for tag selection.

From the background of the standard, it can be seen that the early ARC certification was aimed at the needs of the clothing and retail industries. However, with the development of the industry, this certification body is also gradually evolving, and the scope of application scenarios is gradually developing towards express parcels, food & medicine and other industries.

Why does ARC certification have such a big impact on the domestic RFID supply chain? There are two factors that cause this phenomenon.

First, the ARC certification market is large enough.

According to data from the RAIN Alliance, the global shipment of UHF RFID tag chips reached 44.8 billion in 2023. Moreover, it has maintained a 20-30% increase in recent years. If we look at this "big market" figure, the global RFID passive Internet of Things industry market is still considerable, but for domestic RFID tag suppliers, they have not felt the rapid growth of the industry. The main reason is that the growth of global UHF RFID tags mainly depends on some single large customers.

For example, UPS began to use RFID tags on a large scale in 2023, and the increase brought by a single customer is expected to exceed 5 billion pcs. In addition, the increase in the penetration rate of Walmart orders has also brought billions of pcs of growth. These major overseas customers all require RFID tags to pass ARC certification. According to our statistics, the global market that requires ARC certification accounts for more than 70% of all UHF RFID tags, so the market size of ARC certification is very large.

Second, the domestic UHF RFID tag supply chain basically cannot enter the ARC system.

Because the ARC certification targets the performance of the tag, the suppliers of the UHF RFID tag product line are mainly affected. For example, there are more and more domestic UHF RFID chip manufacturers in this track, but they can only "look on with regret" in the ARC market.

The same is true for domestic UHF RFID Inlay manufacturers. It is precisely because they cannot enter the ARC system that domestic tags can only be rolled in the domestic market. Once a large-scale domestic project appears in the market, it will be rolled into a twist. Domestic composite manufacturers do not have ARC requirements. Many domestic label composite factories have taken over some ARC label projects. Domestic reader manufacturers do not have such restrictions, but overseas major customers generally have requirements for chip solutions.

ARC's enlightenment: The key to better development of the domestic RFID industry lies in domestic applications.

The most critical factor for the RFID industry chain to have an "ARC" certification is that the terminal demand customers are mainly large retail customers in Europe and the United States. This is also the reason why foreign countries can hold back. Even if there is no ARC, in the current market environment, there will be other certifications to replace the role of ARC. Therefore, if the domestic RFID industry wants to develop and break through, a very important condition is that domestic users must account for a large proportion of the RFID tag application market.

When an industry has a scale, unified standards are a must. At present, the domestic RFID passive Internet of Things industry is developing in full swing, and there are more and more calls in the market to establish a Chinese standard similar to "ARC". In any case, ARC is still a very successful organization, and domestic standard organizations should also refer to its model.

First of all, its establishment was led by retail terminal demand parties such as Walmart, while domestic technical product standards are basically

led by upstream suppliers, which forms a sharp contrast, because only the application demand party understands the demand best, and thus forces the upstream product technology to iterate and evolve.

Secondly, within the ARC system, it is relatively less competitive, and the distribution of production capacity is more reasonable, which can not only avoid insufficient production capacity, but also effectively prevent overcapacity, and the price and profit of suppliers are also more reasonable, which is more conducive to the development of the entire industry.

2. In the RFID industry, do you want shipments or profit margins?

In the RFID industry (even in all walks of life), companies are faced with a choice: shipments? Or profit margins? Of course, if both can be achieved, that would definitely be the most perfect solution, but the reality is that in many cases, both cannot be achieved.

Why is it difficult to achieve both? Because you want shipments or profit margins? For a company, these are two different business paths:

To achieve shipments: The main indicator pursued by the company is volume. With large shipments, the market size will naturally increase, and the market share will be greater. The characteristics of a large market are: high degree of standardization, large customers or high customer concentration, which is conducive to the rapid expansion of the company, and correspondingly, it is also easy to roll inward.

To achieve profit margins: The company pursues a profitable market. Such a market will perform better in terms of overall price and profit because of relatively small competition, severe customization, and more after-sales operation and maintenance services. But at the same time, such a market is generally more stable and it is more difficult to expand in scale.

For an industry, in the early stages, due to the small shipment volume and high marginal cost, products generally maintain a high gross profit level. As the industry grows and matures, the shipment volume of products will increase 10 times or even 100 times, and the cost and price of the corresponding products will also decrease a lot (the specific reduction will vary greatly from industry to industry), but in general, the market size of the industry will increase with the increase in shipment volume.

However, under some specific conditions, there will be a phenomenon: the shipment volume has increased, but the revenue scale has not increased. This phenomenon is not uncommon in some market segments of the current RFID industry.

For a simple example, in a certain segmented scenario, the annual shipment volume of UHF RFID readers was 1,000 units/year 10 years ago, and the unit price was 10,000 yuan 10 years ago, so the market capacity was 10 million/year. After 10 years of development, the industry has grown to 10,000 units/year, but the price of UHF RFID readers has also dropped to more than 1,000 yuan per unit, and the total market output value has not increased much.

Although the cost has also dropped, it is obvious that the profit margin of the enterprise has also dropped a lot. Therefore, for enterprises, they often need to make a choice, is it to choose a market with shipments or a market with stable profits? Because no matter which way to go, the survival and development of enterprises are common goals.

Next, let's discuss in detail how to analyze the market with shipments and the market with gross profit margin in the RFID field.

Which are the markets with shipments?

Application scenarios	Shipment levels	Why is there volume
Supermarkets and department stores	Currently, Walmart, Target, Macy's and other overseas supermarkets are using RFID tags on a large scale, with annual shipments at the level of 10 billion PCS	Driven by giants, customers are concentrated, and the volume of a single customer can reach more than 100 PCS.
Shoes and clothing	Major footwear and clothing brands such as Adidas, Nike, Uniqlo, ZARA, Decathlon and Anta are all using RFID tags, with annual shipments at the level of 10 billion PCS.	Customer concentration is also very high, with the volume of a single customer ranging from hundreds of millions to billions of PCS.
Express parcels	UPS has already used RFID tags on single-item express parcels, and domestic transit bags have already widely popularized RFID tags, with annual shipments at the level of 5 billion PCS.	Customer concentration is very high, with the volume of a single large user ranging from billions to tens of billions of PCS

We have selected several markets with relatively large RFID tag volumes and sorted them out.

Because RFID tags are cheap, the screening conditions for the markets with relatively large volumes are: the total volume is more than 5 billion PCS, and the volume of a single customer is more than several hundred million. In addition to the markets listed above with a volume of more than 5 billion PCS, there are many markets with a volume of more than several hundred million PCS, such as books and archives, food and medicine, airline luggage, etc.

Which markets have profit margins?

Application scenarios	Profit margin level	Why is there a profit margin
Power industry	The RFID market in the power industry depends on specific situations. For general meter tags, the gross profit level is not high, but for some special tags, the gross profit can be as high as 50% or more.	Customers are dispersed, the number of single customers is small, and the marginal cost of customer customization is high.
Industrial manufacturing	RFID tags for industrial manufacturing also depend on specific scenarios. If the customer has a large volume, the gross profit level is also average. If the volume is small, the gross profit can also be more than 50%.	Customers are dispersed, the number of single customers is small, and the marginal cost of customer customization is high.
Medical	RFID tags in the medical field also depend on specific scenarios. If the customer has a large volume, the gross profit level is also average. If the volume is small, the gross profit can also be more than 50%.	Customers are dispersed, the number of single customers is small, and the marginal cost of customer customization is high.

Of course, there are many markets with high profit margins, including campuses, municipal management, casino chips, animal management, and national military standard markets.

In fact, under the current situation of information transparency and industry involution, it is difficult for us to find a market that is 100% guaranteed to have a high profit margin, because this is a false proposition. Its logic is that if a certain industry has a high gross profit margin and the market has some scale, then such a market will definitely attract many players to enter, thereby lowering the industry's gross profit margin.

Therefore, we can only look at such markets according to the situation.

According to our understanding of the industry, in order to form a high-gross-profit market, in addition to the conditions listed in the table above, such as customer dispersion, small number of single customers, customer customization, and high marginal costs, some factors of human intervention need to be added: for example, market access qualification threshold (a small number of players are allowed to enter, so there is not so much competition), market information gap (secretly making money).

Finally, in summary, there is no difference between the above two business paths, depending on the company's own goals and choices.

3.Why reasonable profits are the cornerstone of the healthy development of the RFID industry

To analyze this issue, the author first takes something that happened around him as an example: A friend who often drinks coffee recently posted a dynamic in the circle of friends: "Luckin Coffee's discounts are getting less and less, and the industry needs a "catfish" (new player) to teach Luckin how to do things."

This phenomenon is very interesting. In order to seize the market or even monopolize the market, many businesses will use commercial means such as low prices/subsidies to make competitors withdraw from the market. This strategy is simple and crude, and the effect is direct.

The reason why this strategy is so effective is that there is a default premise, that is, consumers (users) are very sensitive to prices, and the consumer behavior rule of most people is: choose whoever has the lowest price.

So does this idea work in our RFID industry? This article will discuss it in detail.

The RFID industry is seriously involuted, and the essence is a result of oversupply

The RFID industry is very volatile, and relevant practitioners should have a deep understanding of it, but in fact, in the domestic market, the price volume is far more than just our RFID industry. It can be said that any open market (without too much human intervention), as long as the market looks good, is rolled into a dough.

This is true for both the B-end market and the C-end market. The author believes that the essence of the RFID industry volume is a result of oversupply.

The RFID industry, especially the UHF RFID industry, has maintained a growth trend in the past 20 years, and this growth trend will continue for a long time in the future. Although the application demand is growing, the supply side of the RFID industry is growing faster. Therefore, the industry will inevitably form involuntariness when the supply increases.

Should we have involution? Different people have different opinions

The first opinion: This phenomenon is undesirable.

Because the industry is too competitive, no one can make money, and some even lose money to gain publicity, especially for small and medium-sized suppliers, whose scale is small and the cost of their products is high. If the competition is further competitive, it is easier for the business to fall into trouble.

Even an important reason for many unfinished projects is because of "low-price bidding". After the low-price bidding, suppliers may reduce configuration and reduce costs, resulting in poor project results, thus forming a vicious cycle, which is harmful to the development of the industry.

The second voice: This phenomenon is positive overall and is a driving force for the development of the industry.

This idea is to think from the perspective of end users, because for end users, under the condition of meeting the needs, of course, the lower the price, the better, and for suppliers, after the price is rolled down, more RFID markets with shipments may be released, making the industry's plate bigger.

The development and growth of a technology industry is to continuously iterate and improve the cost-effectiveness: either the performance remains unchanged and the price is reduced; or the price is stable, but the performance continues to improve, so that the industry can have the motivation to move forward.

I will not easily judge which of these two voices is more correct. Because the conflict behind is the interests of upstream suppliers and downstream users, so let's discuss whether there is a compromise solution to balance the needs of both?

What are the needs of suppliers?

Making money is definitely the first need. What comes after making money? It is to make money steadily for a long time, not a short-term business, so that a company can grow and develop for a long time.

What are the needs of end users?

Save money while meeting their own needs (if the needs cannot be met, there is no market to talk about). What comes after finding a supplier who saves money? It is definitely hoped that this supplier can cooperate for a long time and not be changed casually.

Suppliers want to make money VS users want to save money. This point is determined by the positions of both parties and cannot be changed. However, considering the long-term development of an enterprise, the two can find a balance at this point.

Because suppliers certainly hope that Party A will live better and better, and the demand will exist for a long time. Party A also hopes that the supplier will be stable for a long time and not go bankrupt in the middle. It will be very troublesome to change another supplier and it will bring a lot of extra costs.

So taking a step back, the conclusion is: reasonable profit is a necessary condition for the healthy development of the industry.

What is a "reasonable profit"?

In today's information-based and transparent world, the BOM cost of RFID products is already very transparent. Users can easily know the BOM cost of an RFID tag and the BOM cost of an RFID reader through various channels.

Therefore, many customers' negotiation strategy for suppliers is: BOM+N. This "N" only guarantees the basic operation of the enterprise and does not have much profit space. It is the way of OEM factories, but OEM factories can do this mainly because they are not brands and do not bear the consequences of brand failures.

However, the author believes that an "X" needs to be added. What is this "X"? In fact, it is the insurance premium for the brand protection of the enterprise and the subsequent operation and maintenance services.

Because no one dares to guarantee that a product and solution will not have 100% problems. If problems occur, maintenance costs will be incurred. If Party A does not leave this cost space for the supplier at the beginning, the supplier must bear this cost by itself. If the supplier is relatively large, it can bear it several times. If the supplier is not strong enough, it is likely that it cannot bear it.

4.How can RFID companies break out of the involution?

The RFID industry is very involutionary, and industry practitioners have a deep understanding of this. However, which domestic market is not involutionary? There are many industries whose involution is far more serious than the RFID industry. Since these objective problems that plague the development of the industry cannot be avoided, how can domestic RFID suppliers find a way out?

To answer the above questions, we must first explore the reasons for this problem. The main reasons for the serious involution of the industry are as follows:

First: the industry is oversupplied, resulting in overcapacity

The essence of the internal circulation of the RFID industry is a manifestation of oversupply. Although the shipment volume and demand of RFID have been growing at a relatively fast rate, the production capacity of the RFID supply side has grown faster, resulting in a situation of oversupply.

In the "buyer's market", end users have many options and therefore have higher bargaining power. In order to win customers, especially some benchmark large customers, RFID companies will fight to the death and even lose money to make a profit.

Second: The "ARC certification market" with volume is an artificial bottleneck

For the domestic RFID supply chain, there is another important reason for internal circulation, which is the "ARC certification" bottleneck. According to the statistics of this white paper, the ARC market accounts for more than 70% of the global UHF RFID Inlay tag volume. With such a large volume, the domestic supply chain cannot enter for the time being, so it can only be internal circulation.

Third: General products are highly homogenized. Apart from the price, there seems to be not much to compete for.

The third important reason for the internal circulation is that general RFID tag products and readers (handheld devices, etc.) with highly standardized configurations are less differentiated, so it is easy to fall into price internal circulation.

Analyzing the above reasons and combining the industry information we have learned, the main countermeasures for domestic RFID companies facing internal circulation are as follows:

First, it is to do differentiated markets with prices and profit margins.

Since ARC cannot enter the market with volume, it is an effective means to do differentiated markets with prices and profits. Such differentiated markets have relatively high costs and prices because the overall market demand is not large and the product customization is high (it is not universal if you change customers or industries).

Especially in recent years, we have noticed an industry trend: more and more product-oriented companies are beginning to involve the market of overall solutions. For example, companies that previously only made tags or readers have begun to make overall solutions of "readers + tags + software systems". The products may be integrated with industry partners, but they will take on projects as a whole. Of course, the business model of overall solution projects has both advantages and disadvantages, but because of the good price and profit, it can at least help RFID maintain its basic living space.

Second, do overseas markets

Since the domestic market is so fierce, then go to the overseas market, which is also a common practice in the industry. The logic of going to the overseas market is: there is not so much supply overseas, so the supply and demand are relatively balanced, so that better prices and profits can be maintained. However, as more and more companies go overseas, the supply in the overseas market has also increased, which is equivalent to these domestic companies changing places and rolling together.

After all, it is not as convenient for domestic companies to tap into overseas market demand as in the domestic market. Apart from other things, few companies can build a localized team, and domestic RFID companies have limited channels to contact overseas market demand. But in any case, expanding the needs of overseas customers is a necessary path for the growth and expansion of the domestic RFID industry.

Third, enter the market with threshold qualification requirements

"ARC" is a market threshold qualification, and the volume of ARC is not only large, but the price and interest rate of the product are relatively well maintained.

In fact, in China, there are also many market segments that have their own industry qualification thresholds, such as the State Grid system in the power industry; the Moutai and Wuliangye systems in the liquor industry; the Mindray system in the medical industry; and the national military standard system, etc. Although it is difficult to enter such a market, once you enter, it means that the supply is stable and the price is not so competitive.

Fourth, enter the market with opaque information

This point is very interesting. Now many RFID companies are also doing various vertical market segments. After the market is vertical, the market demand is not so large, so once several suppliers enter the market together, it is also easy to roll inward.

In such a market, it is better to "make money quietly". Many companies are afraid that others will know the information of such market projects. Of course, this is definitely not a long-term approach. On the one hand, in the current era, information will become more and more transparent, and project information will always be known to everyone; on the other hand, perhaps because the scale of the project demand itself is not large, end users do not go around looking for suppliers for comparison.

5. Which comes first, capacity or orders? This is a question

During the research of this white paper, we saw an industry phenomenon, that is, the leading RFID tag factories have been continuously expanding their capacity. Because of the lack of capacity, the leading tag factories will even outsource orders to third-party tag factories.

However, for domestic small and medium-sized tag factories, the speed of capacity expansion has slowed down significantly in recent years. The main reason is that the current capacity can fully meet the demand of orders, so there is no need to expand capacity.

Based on this industry phenomenon, let's analyze the reasons first

First, let's analyze the reasons why the leading RFID tag factories are frantically expanding their capacity. It is mainly because large industry projects represented by Walmart and UPS are using RFID electronic tags in large quantities. After Walmart expands the SKU of RFID tags, its annual RFID tag usage is expected to be more than 15 billion (only in the North American market), and according to UPS's express parcel business volume, its annual RFID tag usage is expected to be about 5-6 billion.

The two major projects bring more than 20 billion RFID tags each year. Since RFID tags are consumables, it is necessary to expand production capacity to take on such an incremental market. Since North American customers such as Walmart and UPS need "ARC" certification, and the RFID Inlay tag factories that have passed the ARC certification are mainly the top non-domestic companies, we have seen the phenomenon that the top RFID Inlay factories have been building new factories and expanding production capacity in recent years.

Then, let's analyze the reasons why the capacity expansion of domestic small and medium-sized RFID tag factories has slowed down a lot. According to our understanding, a few years ago, domestic RFID tag factories carried out a wave of capacity expansion in a relatively concentrated manner. At present, the number of binding machines in most domestic small and medium-sized RFID Inlay factories ranges from a few to more than 10, and the corresponding production capacity is about a few hundred million pcs to a few hundred million pcs.

However, because they cannot enter the ARC market, the main customer groups of domestic RFID tag factories are the domestic application market and the overseas non-ARC market. Although this market is also growing, the growth rate is not as fast as the rate of capacity increase. Therefore, small and medium-sized label factories have a certain surplus capacity, so the expansion speed has slowed down.

To expand capacity or not, this is a question

At the current stage, RFID label factories are facing an important decision, that is, whether to continue to expand capacity. If they want to continue to expand capacity, the problem is obvious, that is, the current capacity is not full, and if the future orders are not ideal, the risk will be very high.

If the capacity is not expanded and the current capacity scale of several hundred million pcs is maintained, it means the risk of losing the large order entry threshold. Because the RFID label market has a very obvious feature, that is, a single large customer has a great impact on the industry. Often a single large customer uses hundreds of millions of RFID labels each year.

And large customers are also strict in choosing suppliers. If a customer uses 500 million RFID labels each year, it is likely to choose a label with an annual production capacity of several billion pcs, because this can ensure that its supply chain is more secure and stable. Therefore, by the same logic, if domestic small and medium-sized label factories maintain their current production capacity of several hundred million, it will be difficult to receive a single large customer with hundreds of millions of pcs.

The current problem is whether there are many customers in the non-ARC market with a single customer demand of hundreds of millions. The judgment of this information is very important for the capacity expansion of label factories.

6.How to play in the special label market?

In the survey of this year's edition of the white paper, we came into contact with a group of companies that make UHF RFID special labels. In the impression of many people, special labels are relatively less involuted because of the high degree of product customization and fewer players, and the companies are doing better, but in reality it is not that simple.

On the one hand, the entry threshold of RFID special labels is low. The low entry threshold of this market is reflected in the following aspects:

First, the technical threshold is low. First, the overall technology of RFID label products is very simple. Second, the production process and antenna design of RFID special labels are also relatively simple. Of course, a lot of know-how is needed to make this product well.

Secondly, the capital threshold is relatively low. The equipment for special labels is much cheaper than the binding equipment for general RFID labels, and the production equipment of many traditional card manufacturers can be reused to produce some types of special labels, so the capital requirements for RFID special label business are not that high.

Finally, there is the market development threshold. Except for a few markets with high qualification thresholds, most markets for special labels are

open markets. Therefore, there are fewer restrictions on the development of special label markets.

On the other hand, the concept of special labels shows that it is a niche market.

If a label has an annual volume of 10 billion PCS, even if its production process is complicated, it is a widely recognized general label, so "special labels" and "general labels" are two relative concepts, the difference lies in whether it is used in large quantities.

In the small-volume special label market, if there are fewer players, the company will have a more comfortable life, and if there are more players, it will also be very serious.

In such a market environment, how should RFID special label companies play?

According to the information we have learned from many RFID special label companies, the core magic weapon for such companies to compete is innovation.

We should constantly develop new customers and even new application scenarios, so as to develop new special RFID label forms and functions in a targeted manner. Innovation is an effective way to avoid internal circulation.

This is also very stressful for companies, because the new market developed by the company will definitely have a group of followers entering this market competition in the near future.

To avoid such competition, the second way to choose is to do a market with high entry barriers. For example, some subdivided industries have high threshold qualifications for the selection of suppliers. Although it is very difficult to enter such a market, once entering this market, shipments and prices will be relatively stable.

7.Can products with very cheap prices really not afford RFID labels?

We have established a model to analyze the potential for large-scale application of UHF RFID tags. The core of this model looks at two points.

The first point is to see what items people consume in their daily lives and are relatively expensive (at least more than a few dozen yuan per unit).

Why do we need to look at the unit price of the product? We consider that the biggest selling point of RFID tags is that they are cheap, so that they can be used as consumables. If they are to find a scenario with a large volume, they cannot be industrial products that are recycled and used multiple times. At present, the label still costs a few cents. If the price of a product is only a few dollars and the profit is relatively thin, it is difficult to afford RFID tags.

The second point is to see which scenarios have a high degree of fit between the business logic and the product capabilities of RFID tags. The product characteristics of RFID tags are cheap, passive (no battery), but can only transmit a small amount of information, which is very suitable for asset management and full-process traceability of products. The scenarios with high business fit with such product characteristics are mainly large quantities of products, used for asset inventory, or visual tracking of product processes, or business needs such as anti-counterfeiting and anti-counterfeiting.

During the research of this white paper, the author discussed the above analysis model with many industry friends. Regarding the second point, everyone agreed, but on the other hand, some people put forward different views on one point.

A different view is that the applicable scenario of RFID tags is not based on the unit price of the product, but on the labor cost of this scenario.

Why do you say that? This starts with the economic value that RFID tags can bring to users.

The economic value benefits that a technical solution brings to users can be reflected in two levels. The first level is to help users bring more income, and the second level is to help users save costs. The economic value that RFID tags can bring to users is mainly reflected in the second level, that is, helping users save costs. What specific costs can be saved?

First, save labor costs. Saving labor costs is mainly reflected in the reduction of labor costs in the inventory of items, and the inventory of items involves multiple links. Taking the clothing scene as an example, manufacturers' inventory of clothing items is not only carried out in the store link, but also in the logistics turnover and product production links. In the inventory of this business link, using RFID tags can save a lot of labor costs.

Second, reduce loss costs. In a scenario like clothing retail, there are various problems in actual management that may cause loss of goods. For example, a product is in the warehouse but it is very difficult to find it; or due to poor management, some products have been shipped out but not recorded in the system. RFID tags can effectively reduce such losses (of course, they cannot be completely avoided).

Third, save time costs. There are several aspects to saving time costs. For example, if you want to find a certain product in a store, you can find it quickly with the RFID solution; for the logistics link, RFID can reduce the overall logistics time; for enterprises, RFID solutions can achieve refined

operations, reduce inventory rates, and thus increase the turnover efficiency of the company's funds.

So why is labor cost so important? There are several factors:

1. The saving of labor costs is the most intuitive for RFID users. Although the benefits of other aspects are good for enterprises, the benefits are not as obvious as saving labor costs. The most direct feeling of the shoe and clothing brands that have already launched RFID tags is the reduction of labor costs.

2. The cost savings at other levels can actually be converted into labor costs in the end. For example, reducing losses can be solved by increasing labor and management costs. Saving time costs is also another dimension of saving labor costs.

Therefore, based on this logic, the premise for the large-scale application of RFID tags is how much labor cost savings can be brought to this industry.

Then our model for potential application scenarios of RFID tags can be optimized as follows:

First, consider the fit between the business logic of this industry and the RFID product.

Second, does this industry require a large number of workers, because only industries that require a large number of workers have the most obvious benefits in saving labor costs.

Third, is the salary of the labor cost of this industry very high?

According to this logic, it can also explain why the footwear and clothing retail industry and the express logistics industry are currently the two most concentrated application scenarios of RFID tags.

As for the express logistics scenario, it needs to be discussed separately.

We know that UPS in the United States has popularized RFID for every express package, becoming an industry benchmark, while the domestic express industry has not yet had much information on the implementation of RFID tags in single-item packages.

Previously, many industry friends believed that the main reason was that the domestic express logistics industry had too low customer price per order, especially for e-commerce orders, where the price per order was reduced to 1-2 yuan, while the average price per order of UPS was as high as several US dollars. Under the condition that the prices of RFID tag products were similar, UPS's ROI was easier to calculate.

But from our analysis today, we can find that this statement is not rigorous. Obviously, the calculation method of ROI of RFID solutions has no direct relationship with the unit price of goods.

The biggest reason why American express companies such as UPS use RFID tags is not because of the high unit price of its products, but because of its high labor costs. In developed countries in Europe and the United States, labor costs are notoriously expensive, and its ROI can naturally be calculated using RFID solutions.

In the same way, Decathlon's products are cheaper than many domestic shoe and clothing brand manufacturers, but it also uses RFID solutions very well.

So whether RFID tags can be used in this industry has nothing to do with whether the industry has money? The author believes that it is not completely unrelated.

Because if an industry has no money, it will be in a loss every year, and of course it will have no money to invest in new solutions. The fact that the domestic express logistics industry cannot afford RFID tags is directly related to the low gross profit margin of this industry. According to information from several domestic express listed companies, the gross profit margin of the domestic express logistics industry is only a few percentage points to more than ten percentage points.

If the industry has no profit, there will naturally not be much budget to invest in new information solutions.

Finally, let's talk about the investment-output ratio of RFID solutions.

The point we have been discussing before is that RFID brings users the economic benefit of cost reduction, but there are other aspects of RFID ROI. For example, anti-counterfeiting traceability, anti-mixing management, and full-process traceability of product information.

These effects cannot be directly reflected in economic benefits, but with the development of society, more and more countries have higher requirements for product safety and green environmental protection, and such management requirements are also a great help to the development and growth of the RFID industry.

8.Is UHF RFID positioning reliable?

During this year's white paper research, we saw that UHF RFID's high-precision positioning capability has attracted much attention. The author has also been paying attention to the high-precision positioning market for a long time, so this chapter will focus on this issue.

Can UHF RFID do high-precision positioning?

First of all, the answer is that UHF RFID can do high-precision positioning, but the accuracy is about 1 meter.

When using UHF RFID as a positioning solution, the core device is the reader using a phased array antenna. Regarding the principle of phased array antennas, Mr. Gan Quan's book "Internet of Things UHF RFID Technology Products and Applications" has a detailed description, and we will quote the relevant content.

Principle of Phased Array Antenna

Phase array antennas, also known as phased array antennas, refer to antennas that change the shape of the directional pattern by controlling the feeding phase of the radiating unit in the array antenna. Controlling the phase can change the direction of the maximum value of the antenna directional pattern to achieve the purpose of beam scanning. It can be simply understood that traditional antennas have only one fixed radiation pattern, while array antennas can have multiple radiation patterns in different directions. When a phased array antenna is used in an ultra-high frequency RFID system, one antenna can be turned into multiple antennas in different directions. As shown in the figure below, this is a gateway radiation diagram with a phased array antenna. The original antenna main lobe radiation axis θ=0°. After the phase adjustment of the specified radiation unit in the array antenna, its main lobe radiation axis will deflect, and the maximum deflection can be 45°. Compared with the traditional solution, the phased array gateway using the scheme shown in the figure below has a greatly increased coverage range. The original 3dB radiation angle was 30°, and now it has become 120°.

Gateway radiation diagram of phased array antenna
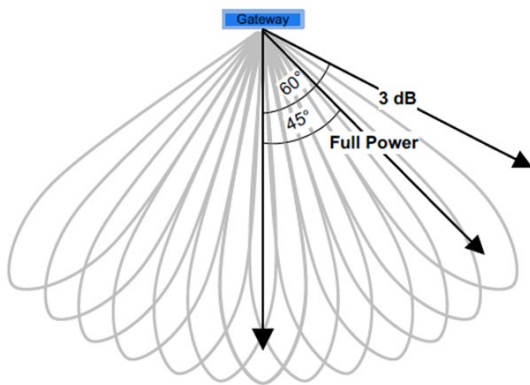
The specific operation of the phased array gateway can be understood as a single-port reader becoming a multi-port reader (how many combinations of phases correspond to how many ports). The original single-port reader can only connect to one antenna with a fixed radiation range, while the multi-port reader can connect to many antennas, and each antenna has a different radiation range. This multi-port reader can select the area to be scanned according to the needs and start the corresponding port to transmit the signal through the corresponding antenna to cover the specified area.

Phased array antenna positioning function

Regarding the positioning function of UHF RFID readers, let's take two common phased array gateways (readers) on the market: Impinj's xSpan and xArray as examples.

xArray is a square phased array gateway. When xArray is hung on the roof, its coverage area is a circle with 8 sectors and 52 radiation areas. It can be simply understood as a 52-port reader connected to 52 antennas in different radiation areas.

xArray's beam pattern
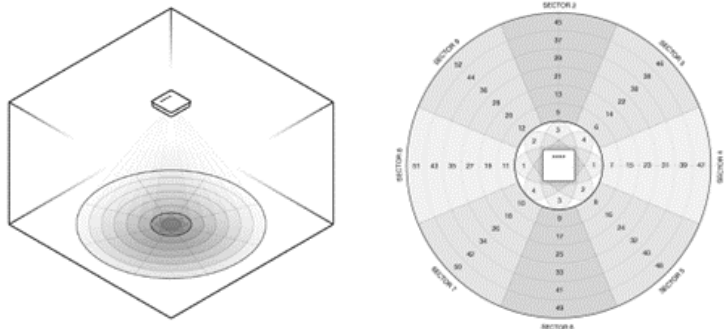
xSpan is a rectangular phased array gateway. The xSpan gateway can be seen as a simplified version of the xArray. When the xSpan is hung on the roof, the area it covers is a rectangle with a total of 13 radiation areas. It can be simply understood as a 13-port reader connected to antennas in 13 different radiation areas.

🔴 **xSpan beam pattern**
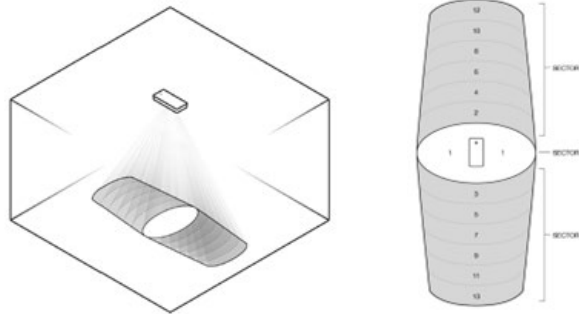
In the actual environment, adjacent numbered radiation areas overlap each other. When the same tag is identified in multiple numbered radiation areas, the specific location of the tag can be calculated by the RSSI size. The calculation process is to convert the RSSI difference into a distance difference, and then implement it through a multi-point positioning algorithm. Of course, the tag is likely to fall in the radiation area with the largest RSSI value.

The biggest function of the phased array gateway is positioning, judging the location and movement of the object. The following figure shows the tag movement mode that can be tracked by xSpan and xArray. Among them, xSpan can only track the tag movement in one axis direction, while xArray can track tags moving in multiple different directions.

🔴 **Phased array gateway direction tracking**
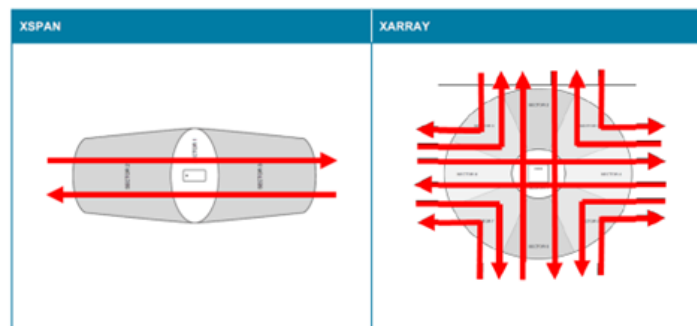
In order to ensure the real-time tracking of objects, it is necessary to ensure that the antenna switching speed is fast enough. Even if each switch is 50ms, it takes 2.5s to scan all the radiation areas of the xArray. Therefore, in the application of object tracking, the number of tags in the field should be guaranteed. If high-precision tracking is required, the number of tags should not exceed 20; if high-speed tracking is to be achieved, the number of tags should not exceed 50.

In actual tests, there are certain errors due to various reasons. In an ideal environment without occlusion and reflection, the measured data is: there is an 85% probability error within 1.5 meters. The error will be greater in complex environments, especially in retail stores with shelf and wall reflections, and the stacking and placement height of tags will have a great impact on the test accuracy. However, compared with traditional technologies, the use of phased array gateways greatly improves the accuracy and convenience of object positioning and finding.

In addition to Impinj's reader/writer equipment, Zebra's "ATR7000" is also a UHF RFID reader/writer that focuses on real-time high-precision positioning capabilities, and it has been widely used in many overseas projects. However, the author understands that the positioning accuracy of this solution is also around 1m.

Earlier news reports said that the research team of Shanghai Jiaotong University used UHF RFID to achieve centimeter-level positioning research results, and the author has also communicated with the team. According to the author's understanding, the team's optimization of positioning accuracy is mainly reflected in the algorithm level. In their solution, first, the phase information of the tag reflection signal needs to be read through the reader/writer array antenna of manufacturers such as Impinj, and then the positioning algorithm is optimized based on the phase information. And centimeter-level positioning accuracy is the effect achieved in a relatively ideal environment. To achieve such accuracy, many specific conditions are

required. If in a general environment, based on algorithm optimization, the positioning accuracy of the UHF RFID positioning solution is improved from about 1 meter to decimeter level, it will be a major breakthrough.

What scenarios are suitable for UHF RFID high-precision positioning?

The positioning accuracy of UHF RFID is about 1m, which also belongs to the category of high-precision positioning technology. The wireless positioning technology with the best positioning accuracy on the market is UWB, which can achieve centimeter-level positioning accuracy in an ideal environment, but in actual applications, it is likely to be decimeter-level; and the positioning accuracy of Bluetooth AoA is only meter-level, and the accuracy of Bluetooth's next-generation positioning technology "Channel Sounding" is also about 1m, so the positioning accuracy of UHF RFID is not bad.

Why are UWB and Bluetooth the mainstream positioning technology solutions on the market? The author summarizes the following reasons:

First, the reader-writer equipment for UHF RFID positioning is very expensive. The unit price of several known UHF RFID reader-writer products that can perform high-precision positioning is more than 1W in RMB, which is more expensive than the base stations of Bluetooth and UWB. If you want to achieve the coverage of the positioning network, for example, to deploy one at a distance of 10m, the cost can be imagined.

Second, it is limited by the scene of RFID tags. Because RFID tags are passive, if you want to realize the positioning and tracking of these tags, you must first read these tags. In actual applications, there are various problems, such as the tags being blocked, the tags being in a metal environment, the location and angle of the tags being improper, etc., which may cause the reader-writer to fail to read the tags, and there is no way to talk about positioning.

Therefore, although RFID tags are very cheap, much cheaper than Bluetooth tags and UWB tags, their application scenarios are still relatively limited. The author understands that the current applicable scenarios of UHF RFID high-precision positioning solutions are mainly concentrated in warehousing and logistics scenarios.

The first is that the warehousing and logistics environment is open, with few obstructions, and RFID tags are easy to read.

The second is that the business logic of this scenario requires extremely low Tag costs, because the previous and next links of warehousing and logistics are likely to need to track the item. For example, from the warehouse to the store, such a Tag will be transferred with the item, and it can be read with a handheld device or other fixed reader in the next link.

If you use solutions such as UWB or Bluetooth, although it can be used in the warehousing link, the previous or next process of this link cannot be used without UWB or Bluetooth network environment, resulting in a higher overall solution cost. This business logic is the same as the 5G passive IoT needs to find a scenario that can reuse the 5G network.

Future Vision of UHF RFID High-Precision Positioning

Finally, the author talks about his personal thoughts on UHF RFID high-precision positioning solutions.

Regarding the issue that UHF RFID high-precision positioning readers are expensive, this is mainly due to the industry chain. Because of the small quantity, the R&D cost from chips to finished readers is very high. Once there is a large quantity, I believe that its price will not be more expensive than UWB base stations.

As for the problem of tag reading, I think this point is the biggest obstacle to the application of UHF RFID high-precision positioning solutions.

According to our understanding, the 5G cellular passive IoT solution currently promoted by Huawei and operators may be optimized at this level. Of course, the 5G cellular passive IoT standard has not been frozen yet, and the first step is to realize its connection capability. In the future version evolution, high-precision positioning may be an important selling point, because from the market demand we see, in addition to the management of existence, the monitoring of location information is also the core business process of many scenarios.

The evolution of the industry is like this: I am not afraid of no products, but I am afraid of no demand. As long as there is demand, I believe that there will be matching products on the market.

9.Can RFID consumer-level application scenarios take off?

In this chapter, we discuss the prospects of RFID solutions in consumer-level application scenarios. Although the current usage of RFID tags is large, most of them are still concentrated in B-end scenarios, and there are not many scenarios where C-end and individual consumers can interact directly.

Let's first briefly review the RFID tag products that are currently used on the C-end.

There are still many C-end scenarios for HF frequency band products. Common scenarios include using mobile phones to conduct anti-counterfeiting and traceability applications for valuable items such as high-end liquor; using NFC to pay, pass access control, pass gates, etc.; using NFC to achieve pairing and control of electronic products, etc.

Because UHF band products are not embedded in mobile phones, it is much more difficult to enter the consumer market. We have seen that some companies on the market are trying to make consumer-grade UHF RFID reader products. For example, Guoxin IoT has released a UHF RFID portable reader, which is very small and can be directly connected to mobile phones, so as to interact with surrounding RFID tags through mobile phones; another example is Bowei Intelligent released a portable reader product for personal consumption, which is used to find items in daily life; in addition, some teams in the industry have released wristband readers such as bracelets/watches for easy use in consumer scenarios.

It can be concluded that RFID needs to enter the consumer scene mainly depending on the following points.

First, it depends on whether the mobile phone supports it. This point is very critical, because individual consumers are very sensitive to price. If consumers are required to buy a reader product separately, the threshold for use is much higher. At present, we have seen that IoT products entering the consumer scene are all taking the mobile phone route. From the performance of HF and UHF, it is also intuitive to see that there are many HF band consumer application scenarios supported by mobile phones.

Second, after the mobile phone supports it, it depends on whether the scene needs it. In the past few years, many people in the market think that NFC is not a very successful technology, because although the mobile phone has popularized the NFC function, most people do not use it. The main reason is that there are not many application requirements for it.

If all mobile phones support UHF RFID passive Internet of Things, what new application scenarios will it bring?

Daily search for objects is a common demand, such as finding a small object at home, which is often not easy to find. This demand point is also painful. The disadvantage of other solutions on the market is that the tag is too expensive, and the UHF RFID tag is the optimal solution. In addition to this demand, there is also a certain demand for anti-counterfeiting traceability and connection and interaction with other IoT products.

10.Can RFID products really be environmentally friendly?

Technology and environmental protection are the two core themes of the development of today's society, and passive Internet of Things technology is the best combination of the two era themes.

Because the hardware foundation of digitalization is electronic devices such as chips, antennas, PCB boards, and batteries, conventional electronic products will more or less bring electronic waste, including metal pollution such as gold, silver, copper, and aluminum. In addition, the batteries that provide energy to these electronic products will also bring more serious chemical pollution.

RFID passive IoT products have no batteries, so this part will reduce a lot of pollution. Although RFID tags also use silicon-based chips and metal antennas, because of their small size, the overall pollution to the environment is relatively small. In addition, with the evolution of the RFID industry, environmentally friendly RFID tag products have gradually matured and begun to be introduced by the market.

According to the information we have surveyed, the environmental protection of RFID tags on the market is divided into the following levels.

Primary: Environmental optimization of the production process of RFID tag antennas. The current mainstream RFID tag antenna production process is etching, which uses strong acid and produces chemical waste. Environmentally friendly antenna production processes mainly include die-cutting industry, screen printing, laser cutting, etc. Although they are environmentally friendly, they still have metal antennas and silicon-based chips.

Intermediate: Optimize the material of the antenna and use a special slurry formula. On the basis of achieving the electrical properties of the antenna, biodegradation can also be achieved, and the antenna can be directly printed on the paper substrate. In this way, except for the chip, the other components of the entire RFID tag can be directly degraded. At present, there are also a number of label factories on the market that have launched such products on the market.

Advanced: The chip can also be directly degraded. At present, there are also some innovative companies and teams in the market that are exploring the realization of non-silicon-based RFID chips. Because the function of the RFID chip is very simple, it can theoretically be replaced by some other materials.

At present, environmentally friendly RFID tag products on the market have gradually become a hot spot in the industry, especially in developed countries in Europe and the United States. The market recognition of environmentally friendly products is gradually increasing. Many users are willing

to pay a certain amount of extra fees for environmentally friendly products. Because in the early stage, environmentally friendly RFID tags are small in scale and expensive, but according to our understanding, as the scale expands, the theoretical cost of environmentally friendly RFID tags can be lower than the current RFID tag cost.

11.What are the market opportunities for 5G cellular passive IoT?

Friends in the RFID passive IoT circle should be familiar with cellular passive IoT. In this white paper and the recent versions of the white paper, cellular passive IoT has been introduced in detail. For related content, please refer to the content of "Part 8" of this white paper.

This chapter focuses on the market opportunities of cellular passive IoT.

According to the propaganda of Huawei and operators, the reason for developing 5G cellular passive IoT is to enter the market that the current RFID cannot enter, because the current RFID industry chain is already very mature and complete, and there is not much meaning in developing the same thing again. Following this idea, let's sort out which markets have demand but cannot be satisfied by RFID at present.

The market that RFID cannot satisfy can be divided into two dimensions.

The first dimension: the market that cannot be satisfied technically. Based on our understanding of the market, the shortcomings of the current UHF RFID solution in practical applications are

The problem of reading distance: The RFID passive IoT solution requires power supply from the reader/writer. Because the energy efficiency of electromagnetic wave far-field radiation propagation is limited, the reading distance has always been a problem that plagues the development of the industry.

Group reading efficiency: In the management scenario of dense assets, the RFID solution is required to quickly count more than 1,000 items. If the inventory is slow, multiple devices will need to be counted multiple times, which affects the efficiency of the entire business process.

The problem of tag reading accuracy: Under ideal test conditions, the tag reading rate of the current RFID solution is close to 100%, but in actual scenarios, due to occlusion, stacking, and the orientation of the tag antenna, the reading rate will be much lower.

Unable to read in real time: At present, the use of RFID solutions is to conduct scheduled or fixed-point inventory according to business needs. Because it is not networked, it is impossible to achieve real-time inventory like other connection solutions.

From a technical point of view, can cellular passive IoT solve these problems?

According to our understanding, cellular passive IoT technology has certain optimizations in reading distance compared to RFID, mainly through the improvement of chip sensitivity and the increase of reader transmission power; and in the two indicators of group reading efficiency and reading accuracy, there is currently no actual data support in cellular passive IoT. According to the publicity materials, there is an improvement, but the actual situation remains to be seen; and real-time reading is the biggest highlight of cellular passive IoT compared to RFID.

In general, cellular passive IoT has technical improvements compared to RFID solutions, but this solution will also increase costs. Whether customers are willing to accept it needs further analysis.

The second dimension: the market that cannot be satisfied at the commercial level. What are the commercial factors?

The first is market recognition, especially for governments, state-owned enterprises, and institutions. The choice of solutions is often guided by policies and the technical solutions promoted by the government will be selected. In this regard, 5G cellular passive IoT has its natural advantages.

The second is to consider the overall cost of the solution. How to understand this point? We know that for users, its digital solution must be a complete set of multi-level requirements. If users want to use RFID, they have to use a new set of things and cannot reuse with other solutions.

If the 5G cellular passive solution is used, although the 5G small base station (reader) will be much more expensive than the RFID reader, the 5G small base station can also be used for communication transmission, positioning, radar and other functions. If it is for users who are already covered by the 5G network, the reusability is very high and the overall cost is relatively low.

Therefore, based on the above considerations, the author believes that the application scenarios of 5G cellular passive IoT are mainly:

First, it is the government and enterprise customers currently promoted by the 5G network, such as state-owned enterprises/central enterprises, government public utilities, etc. Considering the reusability of the 5G network and the asset management needs of these government and enterprise users, the cellular passive IoT will be implemented faster among such users.

Second, in large-scale logistics warehousing environments, the scene has a high degree of automation, and the scene is empty, and there are many

and concentrated items to be managed. Using 5G cellular passive can reuse the 5G communication network on the one hand, and on the other hand, the real-time supervision requirements for items are also relatively high.

Third, there are other scenarios with strong demand for asset management. Even if there is no 5G network coverage, there are still scenarios with strong demand for asset management, such as preventing the loss of state-owned assets, using assets as financial collateral, asset supervision of listed companies, anti-counterfeiting and traceability, anti-counterfeiting management, and many other scenarios.

12.Why do the giant operators have their eyes on passive IoT?

In recent years, we have seen that operators and industry giants such as Huawei are actively promoting cellular passive IoT. For these giant companies with annual revenues of hundreds of billions or even trillions, the current RFID passive IoT industry is only a very small market. Why is such a small market valued by these giants?

The author believes that there are mainly the following reasons:

First, asset management is the most common demand among corporate customers. It is understood that each of the three major operators has tens of millions of government and enterprise customers, and the customer base is very large. In addition, operators play the role of "general package integration" in China's economic industrial chain. Combined with the current trend of digital development, if many government and enterprise customers want to upgrade digitally, cooperation with operators is an important way. These tens of millions of corporate business types are of various types, but for any enterprise, asset management is a common basic demand. The demand of a single enterprise may be small, but the market volume added up is considerable.

Second, although the current RFID passive Internet of Things market is still small, it has huge potential. Digitalization has become the main driving force for economic development. In theory, everything needs to be digitized, which is consistent with the concept of "everything can be connected". It just depends on whether the cost can be accepted by the application. According to the current common connection technology, the connection cost is at least about 10 yuan. The application scenarios that can be covered by such a connection cost are definitely limited, while the potential of passive IoT is trillion-level PCS.

The wave of digital economy is coming, and various technologies are currently working. For low-cost, large-connection scenarios, passive solutions are undoubtedly the most suitable, but whether this thing can be successful, we will wait and see.

13.Discussion on RFID tag cost optimization

Although the price of UHF RFID electronic tags is already very high, whether it can be cheaper is still one of the topics that the industry talks about.

At present, RFID tags have been widely used in the footwear and clothing retail industry, and if you want RFID tags to have more application areas, such as express parcels, daily consumables, etc., the price of the tag is still the main limiting factor.

Since the core product of UHF RFID tags is Inlay, and Inlay products are also standard products, we mainly discuss the cost of Inlay.

The cost of UHF RFID Inlay mainly comes from 6 parts, namely chips, antennas, production equipment investment, labor costs, other consumables costs and other operating costs. The cost ratio of each tag is shown in the table below.

48 UHF RFID Inlay Cost Analysis Table

	Chip	Antenna	Production equipment investment	Labor cost	Other consumables cost	Other operating cost
Cost ratio	50%-60%	10%-20%	10%-20%	5%-10%	5%-10%	5%-10%
Cost optimization space	The improvement of chip technology can reduce costs. In addition, a number of domestic chip players have emerged in recent years, and sufficient competition has given rise to a large room for optimization of chip prices.	The most mainstream process is etching, which does not have much room for cost optimization. Die-cut antennas on the market have been applied on a large scale. In addition, screen printing antenna technology has great potential, and new processes can make antenna costs lower.	At present, the price of label packaging machines made by Muhlenberg is relatively high. The optimization method is to replace the equipment with domestic ones. At present, domestic packaging equipment is also widely used in label factories. Composite equipment has basically achieved domestic substitution, and the price is already relatively low.	Labor costs include workers, sales, R&D personnel, etc. Labor costs tend to rise in the domestic market environment.	Including various adhesive glues, PET materials, paper materials, etc. Among them, the more representative one is the conductive glue that sticks the chip to the antenna. This product is monopolized by foreign brands and accounts for a large proportion of the cost.	Including factory rent, water and electricity fees, transportation fees and other expenses. There is almost no room for optimization in this item.

Source: AIoT Xingtu Research Institute | Cartography: AIoT Xingtu Research Institute

From the above table, we can analyze that the cost optimization paths of tags include: chip process improvement and domestic substitution, which can reduce chip costs; antenna process improvement to reduce antenna costs; domestic substitution of equipment such as binding machines and compound machines to reduce equipment investment costs, etc.

14. Why is RFID passive IoT a perfect technology

During our research, some industry insiders described RFID passive IoT technology as a "perfect" IoT technology. At first glance, everyone may be very curious about how there can be perfect things in the world.

Therefore, we need to define a certain scope for the concept of perfection. From a technical perspective, RFID passive IoT certainly has a lot of shortcomings, but if we define it from a business perspective, then RFID passive IoT products can also be called relatively perfect. The reasons are as follows:

First, RFID passive IoT products are the lowest-cost connection solutions on the market

Currently, the market price of UHF RFID universal tag products is only a few cents. In addition, the cheapest Bluetooth tag on the market costs about 10 yuan, and other technical products are more expensive.

In an IoT product, perception + transmission is the most basic hardware foundation. Sensors collect data and communication modules transmit data. RFID tags are typical perception + communication integrated products. Although they cannot actively collect information about the surrounding environment like sensors, RFID chips can record various information in advance, which greatly reduces costs.

In addition, another low-cost advantage of RFID products is that it is a passive technology, that is, it does not require batteries. Battery costs account for a large proportion of the costs of many IoT products, and batteries also require replacement costs. Passive IoT technology greatly saves this part of the cost.

Second, the application scenario is widely applicable

Whether it is a B-end scenario or a C-end scenario, whether it is expensive or cheap, it can be managed with RFID passive IoT tags.

At present, RFID tags have been popularized in many industrial production scenarios, such as automobile production lines, photovoltaic production lines, 3C electronic product production lines, etc. In the C-end scenario, RFID tags are more widely used. The most common ones are product tags for footwear and clothing retail, airport luggage check-in tags, high-end liquor, etc. In the future, they will also be widely used in express parcels, food, medicine and other products.

Third, low threshold for use

A perfect product must consider the convenience of use, because the wider the applicable population, the more mass base it has. RFID electronic tags are such products. It is very light and can be used like a sticker. When the user uses it, he can read the information of the tag by scanning it with a reader product, which is very convenient.

The so-called "Internet of Everything" requires not only the connection of high-value items, but more importantly, the connection of common items in people's production and life. To achieve this, an extremely low-cost and easy-to-operate connection solution is needed, which is a historical opportunity facing the RFID passive Internet of Things industry.

As the most mature passive IoT technology, RFID has been commercially used for decades. However, to solve the connection needs of the trillion-level market in the future, RFID technology needs to keep pace with the times and continue to evolve to have a stronger vitality.

As the largest production base of the RFID passive Internet of Things industry and one of the most important commercial markets, China has a pivotal position in the global RFID passive Internet of Things industry chainTherefore, studying China's RFID passive Internet of Things market has important reference value for understanding the global RFID market and even the Internet of Things market.

Compared with one year ago, the changes in the RFID passive Internet of Things industry are not only the expansion of shipment figures, but also the entry of more heavyweight players and the emergence of more applications and market opportunities.

In this survey, we still surveyed about 100 representative companies and industry experts in various frequency bands and various links of the RFID passive Internet of Things industry chain to complete this white paper.

In this white paper, we divided the UHF, HF, and LF frequency bands into several major frequency bands for detailed market analysis and data presentation of the RFID passive Internet of Things industry, and conducted a comprehensive analysis of the industry chain players and major application areas of each frequency band. In addition, this white paper also separately elaborated on the tag antenna, production equipment and other links to help readers fully and clearly understand the current situation of China's RFID passive Internet of Things market. Of course, due to various reasons, we cannot communicate with all RFID companies one by one and fully obtain the views and information of all companies. If you have any questions about the content of the report, or are willing to communicate your views with us, please contact us (see the back cover for the contact information of the contact person), we will be very grateful.

Finally, I would like to thank all the companies and industry experts who participated in this white paper for their strong support. Thank you for delivering the most cutting-edge first-hand information in the industry, including market data, operating status, industry bottlenecks, industry future forecasts, etc. This information is the most important content support for the formation of this white paper.

Conclusion

物联之星 IoT Star Awards

2023 年度中国物联网企业 100 强

感知层

海康威视数字技术股份有限公司
视频物联网龙头，IoT 业务多元化布局

霍尼韦尔安全与生产力解决方案集团
传感器，自动识别，安防多领域行业巨头

浙江大华技术股份有限公司
视频为核心的智慧物联解决方案提供商和运营服务商

豪威集团 - 上海韦尔半导体股份有限公司上海
国内图像传感器龙头企业，全球排名前列的中国半导体设计公司

复旦微电子集团股份有限公司
物联网安全与识别芯片龙头企业

深圳市远望谷信息技术股份有限公司
全球领先的 RFID 和物联网技术解决方案供应商，国内首家 RFID 行业上市公司

保点贸易（上海）有限公司
全球 RFID 解决方案领导者，RFID 标签龙头企业

上海英内物联网科技股份有限公司
RFID 数据采集专家，物联网智能装备龙头企业

扬州久元电子有限公司
专注 RFID 智能标签生产设备研发及标签生产

深圳市成为信息股份有限公司
PDA 智能终端领先品牌企业

芯与物（上海）技术有限公司
位置服务为中心的物联网芯片及解决方案供应商以精准定位赋能万物智联

励元科技（上海）有限公司
深耕智能制造、数字化供应链、数字化营销、工业物联网平台的解决方案供应商

北京智芯微电子科技有限公司
国家电网直属公司，国内电力及工业 AIOT 芯片领导厂商之一

厦门信达物联科技有限公司
信达物联致力于成为全球最具竞争力的 RFID 产品供应商

紫光同芯微电子有限公司
业界领先的半导体解决方案提供商

泰科（北京）安装工程有限公司
国际领先的物联网智能零售方案提供商

兆易创新科技集团股份有限公司
构建"存、算、感"一体化芯生态，为物联网领域提供全方位服务

福建新大陆自动识别技术有限公司
一家全球化的感知识别和机器视觉产品与解决方案提供商

湖南国科微电子股份有限公司
国内知名芯片厂商，业务覆盖视频编解码、固态存储、物联网等

深圳市汇顶科技股份有限公司
指纹芯片龙头，正全面布局"传感 + 通信 + 安全"AIoT 业务

深圳市亿道信息股份有限公司
国内知名的移动终端、行业应用终端、物联网系统解决方案上市企业

汉威科技集团股份有限公司
国内气体传感器及物联网解决方案头部提供商

安富利电子科技（深圳）有限公司
全球领先的电子元件和服务提供商

思特威（上海）电子科技股份有限公司
全球知名 CMOS 图像传感器产品提供商

宁波柯力传感科技股份有限公司
全球称重领域物联网研发与推广应用的主要引领者之一

深圳市同为数码科技股份有限公司
行业领先的安防视频监控设备及系统解决方案供应商

广东九安智能科技股份有限公司
全球领先的智慧物联网平台综合运营服务商和智能家居产品提供商

深圳市华盛昌科技实业股份有限公司
国内领先的测量仪器仪表和物联网应用解决方案一体的国家级高新技术企业

四方光电股份有限公司
国内气体传感器及物联网解决方案头部提供商

麦克传感器股份有限公司
服务全球的知名工业测控仪表和物联网解决方案提供商

苏州寻息电子科技有限公司
室内位置服务和物联网领域完整产品体系领先企业，化工行业领先优势明显

长视科技股份有限公司
以视频为核心的物联网解决方案提供商

广东奥迪威传感科技股份有限公司
国内超声波传感器领先企业及物联网智能传感器解决方案商

深圳富视安智能科技有限公司
提供从边到云定制服务的软件、硬件、产品化、制造四位一体的专业产商

杭州宇泛智能科技有限公司
国内领先的智能建造与空间数字化服务商

芯海科技（深圳）股份有限公司
集感知、计算、控制、连接于一体的全信号链 AIoT 芯片企业

深圳市民德电子科技股份有限公司
中国首家实现独立自主研发条码识别设备的民族科技企业

上海司南卫星导航技术股份有限公司
国内卫星导航定位领域领先企业，产业链一体化优势明显

广州英码信息科技有限公司
一站式 AIoT 产品服务，打造"边 - 端"协同产品与解决方案

聚辰半导体股份有限公司
深耕数据存储、汽车控制和智能卡安全等物联网芯片的上市公司

传输层

华为技术有限公司
全球领先的信息与通信解决方案供应商

中移物联网有限公司
物联网连接数全球第一，引领物联网全产业链国产化

上海移远通信技术股份有限公司
全球物联网服务商龙头，Redcap+ 边缘算力带来新机遇

深圳市广和通无线股份有限公司
23 年业绩预告亮眼，积极发展 RedCap 助各行业抢占 5G-A 产业制高点

美格智能技术股份有限公司
以"连接之力"构建更加高效、便捷的智能新时代

广东九联科技股份有限公司
智慧互联综合服务商，"鸿蒙 +"助力业务新成长

翰捷科技股份有限公司
国内稀缺的无线通信基带厂商，国产替代大有可为

利尔达科技集团股份有限公司
物联网模组及系统解决方案一体化企业，抢先布局星闪业务

日海智能科技股份有限公司
5G+AIoT，行业领先的人工智能物联网服务提供商

深圳市有方科技股份有限公司
提供全球领先、可靠的物联网接入通信，让人类更环保、高效、便捷

物联之星 IoT Star Awards

2023 年度中国物联网企业 100 强

乐鑫信息科技（上海）股份有限公司
深耕物联网 Wireless SoC，AIoT 放量在即

泰凌微电子（上海）股份有限公司
国产无线物联网 SoC 领先企业，技术水平全球领先

深圳芯科科技有限公司 /Silicon Labs
物联网无线连接领域的领导者，无线连接部署 10 亿 +

博通集成电路（上海）股份有限公司
无线连接芯片头部企业，低功耗技术领先

捷德（江西）技术有限公司
全球物联网安全连接市场和技术引领者

厦门锐骐物联技术股份有限公司
一站式物联网解决方案的先行者和市场的开拓者

上海磐启微电子有限公司
智慧物联网、工业物联网芯片领先设计企业，累积出货 20 亿 +

惠州高盛达科技股份有限公司
无线互联模组研发生产的国家高新技术、专精特新、广东省制造业 500 强企业

青岛海信移动通信技术有限公司
国内最早且最具实力的物联网移动终端产品方案提供商

武汉天喻信息产业股份有限公司
中国数据安全领域领先的产品和解决方案提供商

深圳友讯达科技股份有限公司
全球场域网解决方案专家，智慧能源领域领先优势明显

福建省四信数字科技集团有限公司
物联网设备及解决方案服务提供商，致力于让万物更加智慧

北京映翰通网络技术股份有限公司
工业物联网小巨人，AI 赋能智能工业

深圳市宏电技术股份有限公司
全球领先的物联网无线通信产品提供商

厦门星纵物联科技有限公司
全球领先的智能物联网产品提供商

厦门骐俊物联科技股份有限公司
国内领先的通信、定位模组供应商

成都亿佰特电子科技有限公司
专注于物联网通信的高新技术企业，提供无线通信产品及解决方案

成都旋极星源信息技术有限公司
国内领先的基于自主半导体 IP 的无线连接解决方案提供商

深圳杰睿联科技有限公司
全球领先的多样化一站式 eSIM 解决方案供应商

平台层

阿里云计算有限公司
全球领先的云计算及人工智能科技公司

联通数字科技有限公司
政企客户数字化转型专家，数字经济国家队、主力军、排头兵

微软（中国）有限公司
领先科技的引导者

亚马逊云科技
全球云计算领导者

中科创达软件股份有限公司
领先的智能操作系统产品和技术提供商

齐犇科技集团有限公司
领先的 AIoT 物联网服务商

软通动力信息技术（集团）股份有限公司
中国领先的软件与信息技术服务商

三六零安全科技股份有限公司
数字安全的领导者

西部数据公司
全球领先的以数据为中心的解决方案提供商

研祥高科技控股集团有限公司
中国工业互联网行业解决方案的头部供应商

宝德计算机系统股份有限公司
以服务器和 PC 整机的研发、生产、销售及提供相关的综合解决方案商

深圳前海翼联科技有限公司
专注于物联网智慧升级服务的高新企业

深圳市万佳安物联科技股份有限公司
中国物联网行业"云 + 端"一体的创新者、引领者和赋能者

金地空间科技有限公司
集智慧建筑、智慧设备、智慧电梯等空间智慧化服务为一体的多元化企业

中亿（深圳）信息科技有限公司
为不止 3000 万台终端设备以及上万企业提供平台以及无线通信服务

应用层

小米集团
小米及其生态链企业构建起中国 IoT 产业一股中坚力量

京东方科技集团股份有限公司
以半导体显示为核心全球领先物联网创新、传感器及解决方案企业

天翼物联科技有限公司
物联连接全球领先，NB-IoT 连接全球第一

深圳拓邦股份有限公司
全球领先的智能控制解决方案商，提供各种定制化 AIoT 解决方案

汉朔科技股份有限公司
全球领先的智能 IoT 硬件和行业数字化解决方案提供商

上海移为通信技术股份有限公司
全球领先的物联网终端产品和解决方案提供商

苏州清越光电科技股份有限公司
2019 年起 PMOLED 出货量连续多年位居全球第一

深圳市几米物联有限公司
全球领先的物联网位置服务方案商

深圳市智慧城市通信有限公司
致力于成为全球领先的智慧城市信息通信建设运营商

深圳云里物里科技股份有限公司
超低功耗无线技术物联网领先企业，蓝牙传感器领域领先优势明显

元太科技工业股份有限公司
全球电泳式电子纸显示技术的领导开发商与供货商

浙江东方科脉电子股份有限公司
全球规模最大的电子纸模组专业制造商之一

惠州亿纬锂能股份有限公司
全球锂电池头部企业，锂原电池连续 8 年销售额及出口额国内第一

广州鹏辉能源科技股份有限公司
全球领先的锂电池供应商，户储全球第二

宁波金山双鹿电池有限公司
全球一次性电池头部企业，在物联网终端产品广泛应用

物联之星 IoT Star Awards

2023 年度中国物联网企业投资价值 50 强

感知层

精创 江苏省精创电气股份有限公司
国内领先的温湿度监测产品和冷链物联网解决方案提供商

GEOKON 基康仪器 基康仪器股份有限公司
国内野外及基础设施安全监测仪器头部供应商和解决方案商

奥松电子 ASAIR 广州奥松电子股份有限公司
全球少数具有 MEMS 智能传感器全产业链（IDM）企业之一

seeed studio 深圳矽递科技股份有限公司
集具智能传感、边缘计算、网络通信、众创生态一体的创新型物联网科技公司

中芯微 杭州中芯微电子有限公司
国内领先的物联网定位感知产品及解决方案供应商

先施科技 Scate Sense Technology 深圳市先施科技股份有限公司
RFID 技术应用行业解决方案领先企业

MKSEM 北京瀚巍创芯电子技术有限公司
国产化 UWB 落地方案芯片的先行者

Locaris 联睿科技 郑州联睿电子科技有限公司
以高精度定位技术为核心的智能物联领军企业

SILION 芯联 北京芯联创展电子技术股份有限公司
领先的超高频 RFID 模组企业

坤锐 Quanray Electronics 上海坤锐电子科技有限公司
亚洲第一家通过 EPC Global 芯片兼容性 / 标签互操作性双重认证公司

AI TOUCH 隔空科技 隔空（上海）智能科技有限公司
行业领先的射频雷达芯片企业，其中微波雷达市占头部

国芯物联 NATION RFID 深圳市国芯物联科技有限公司
专注于 RFID 超高频芯片、读写器模组研发与生产的行业领先企业

SBR 矽杰微电子（厦门）有限公司
集汽车 / 工业 / 家电等应用的 24/60/77GHz 毫米波雷达芯片及方案

MEOKON 铭控传感 上海铭控传感技术有限公司
国内知名的 IoT 智能传感器制造商和测控解决方案商

OSEMITECH 欧思微 安徽欧思微科技有限公司
UWB 与毫米波雷达芯片领域崭露头角的新星

沧穹科技 ZENITH 深圳沧穹科技有限公司
专注室内定位与导航的领先技术与应用开发商

矽典微 南京矽典微系统有限公司
致力于实现毫米波传感器和射频技术的智能化，为 24G 雷达知名芯片公司

ANDAR 杭州岸达科技有限公司
全球领先的 60 和 77GHz 工业及车载毫米波雷达传感器 SOC 芯片及解决方案商

苗米科技 南京苗米科技有限公司
基于 AI+ 雷达的无线感知系统化能力，打造健康安全的千人千面家居场景

慧闻科技 苏州慧闻纳米科技有限公司
致力于智能传感器，提供人工嗅觉与压感解决方案

勤业物联 深圳市勤业物联科技有限公司
领先的 RFID 产品和解决方案提供商

博纬智能 深圳市博纬智能识别科技有限公司
领先的 RFID 硬件方案商

RZX 融智兴 深圳市融智兴科技有限公司
深耕智能 IC 卡与 RFID 标签研发与生产的行业领先企业

FOSENSOR 福申传感 河南福申电子科技有限公司
深耕智能气体传感器及物联网行业解决方案，发展迅猛

WNK 合肥皖科智能技术有限公司
专注于智能传感器、变送器研发制造，致力智慧城市物联网感知解决方案提供商

传输层

芯百特 CHIPBETTER 芯百特微电子（无锡）有限公司
致力于高性能射频芯片国产化，三合一芯片领先优势明显

集贤科技 ClasSent 深圳市集贤科技有限公司
连接智能世界，引领精彩生活

道生物联 上海道生物联技术有限公司
低功耗广域网技术和芯片解决方案提供商，国产替代前景无限

MobileTek 上海移柯通信技术股份有限公司
全球领先的 IoT 模组以及方案提供商

芯翼信息科技 KYSEMI 芯翼信息科技（上海）有限公司
蜂窝物联智能终端系统 SoC 芯片提供商，国产替代潜力巨大

技象科技 广州技象科技有限公司
100% 自主研发物联专网底层核心通信技术打造物联网感知系统

MINEWSEMI 深圳创新微技术有限公司
一站式物联网无线连接模块供应商

ZIFISense 纵行科技 厦门纵行信息科技有限公司
低功耗物联网技术和解决方案供应商

鲲鹏信息 KEEPSENS 天津鲲鹏信息技术有限公司
无源感知技术提供商，无源物联网领先优势明显

GEO-CHIP 地芯科技 杭州地芯科技有限公司
深耕 5G 射频芯片细分领域，国产替代潜力巨大

blueiot 蓝色创源 蓝色创源（北京）科技有限公司
国内首家、全球第二家量产 BLE-AOA 企业

平台层

潮庭集团 CHAOTING GROUP 广东潮庭集团有限公司
专注于城市物联感知、数字孪生城市、人工智能等技术研发的国家高新技术企业

山东云则信息技术有限公司
专注于物联网平台、物联网模组、物联网终端等技术和销售一体的高新技术企业

SURIOT 速利 杭州速利科技有限公司
一家致力于数字城市应用技术的国家高新技术企业

有人物联 www.usr.cn 山东有人物联网股份有限公司
国家"专精特新"小巨人企业，可信赖的智慧工业物联网伙伴

SPACE iCloud 深圳市思倍云科技有限公司
为空间运营提供数字化产品与解决方案的科技公司

RINO 深圳市犀云科技有限公司
专注于物联网私有云，智能物联网模块的综合技术型解决方案商

铠湾安全 深圳市铠湾安全技术有限公司
智慧消防物联网 SaaS 云平台，消防云平台，安消一体化平台服务商

芯算一体 芯算一体（深圳）科技有限公司
基于 AI 视觉的边缘计算盒子完整解决方案

联了么 LINK LEMO 三棵小草（深圳）物联科技有限公司
致力于成为一家开放的，独立的，第三方物联网云平台企业

iSGR 灵耀数智（苏州）技术有限公司
一家拥有在企业现场运营方面自主知识产权的全栈式 IoT 技术

联乡产发 Country Dev 福建拾联乡村产业发展有限公司
核心打造基于视频及 AI、IoT 核心技术的数字乡村振兴服务平台

应用层

英特灵达 Intellindust 英特灵达信息技术（深圳）有限公司
国际领先的光学成像与视觉 AI 技术，及智能硬件和行业解决方案

星云开物 StarThing 广东星云开物科技股份有限公司
在自助设备第三方物联网平台中，设备终端体量领先企业

mixlinker 智物联 深圳市智物联网络有限公司
服务制造型企业，专注提供"设备物联"和"智慧工业"解决方案

物联之星 IoT Star Awards

2023 年度中国物联网行业创新产品榜

RFID 产品

新零售全频普适标签 GB5OU9 标签
SML 集团

RFID 智能顶装式门禁系统 BRD-17
深圳市博纬智能识别科技有限公司

带电容测量功能的高频 RFID 标签芯片"FM13HM02C"
上海复旦微电子集团股份有限公司

无人机 RFID 机载读写器 +SCTD9039A
北京智芯微电子科技有限公司

X60 RFID 工作站
上海英内物联网科技股份有限公司

XC-FM600 型超高频 RFID 通道机
深圳市远望谷信息技术股份有限公司

超高频 RFID 读写器芯片——GXR-03
深圳市国芯物联科技有限公司

RFID 单张吊牌正背面喷印读写检测一体机 SIM-200D
广州制custom物联网科技有限公司

高防护一体式读写器 HF100
深圳市鸿陆技术有限公司

RFID 无源测温标签
东莞市鸥思物联有限公司

RFID 标签材料
芬欧蓝泰标签（中国）有限公司

RFID 全向标签
江苏康坦科技有限公司

RFID 银浆环保once碎天线
深圳市融智兴科技有限公司

HF 高频标签多工位检测写码机
巨心物联网实验室（深圳）有限公司

智能定位电子工牌 JT-8868
深圳市捷通科技有限公司

VI-IR61 一体式紧凑型 RFID 工业识别读写器
深圳市万全智能技术有限公司

雷丹 RFID 单张吊牌打印机
浙江雷丹科技有限公司

全方位四吋工业型 RFID 打印机 T6000e
天津国聚科技有限公司

RFID 智能定位档案柜 CK-G60H
深圳市斯科信息技术有限公司

新一代 RFID 多功能打印引擎 S84NX
佐藤自动识别系统国际贸易（上海）有限公司

传感器产品

MH-Z9041A 家用激光甲烷传感器
郑州炜盛电子科技有限公司

睡眠监测传感器 SPE-003
苏州慧闻纳米科技有限公司

毫米波传感器芯片 ICL 1122
南京矽典微系统有限公司

智慧养老毫米波雷达传感器
精华隆智慧感知科技（深圳）股份有限公司

60G 毫米波雷达芯片 ADT6101
杭州岸达科技有限公司

路卡手表 +M90
深圳市华盛昌科技实业股份有限公司

智能明火烟雾检测器 FG511
深圳市威视达康科技有限公司

专家级红外热像仪开阳 T630
烟台艾睿光电科技有限公司

海鑫非接触式掌纹掌静脉模组
北京海鑫智圣技术有限公司

定位技术 / 地图 / 可视化软件相关产品

防碰撞报警基站
杭州品铂科技有限公司

IPS 室内定位系统 - 商用版
深圳空循环科技有限公司

银龄守护卡 S342
深圳市几米物联有限公司

4G 智能行车记录仪
中移联合（深圳）科技有限公司

芯与物萤火虫 CC02 系列 GNSS 定位芯片
芯与物（上海）技术有限公司

HY-BI303 UWB-AOA 定位定向模组
深圳华云时空技术有限公司

通信技术相关产品

5G RedCap 模组 SRM813Q
美格智能技术股份有限公司

广和通 5G 智能模组 SC151-GL
深圳市广和通无线股份有限公司

中移 OneMO Cat.1 模组 MN316A
中移物联网有限公司

芯讯通 5G RedCap 模组 SIM8230 系列
芯讯通无线科技（上海）有限公司

国产芯的 LTE CAT4 模组 L508-6
上海移柯通信技术股份有限公司

利尔达 NR90 系列 5G RedCap 模组
利尔达科技集团股份有限公司

千兆卡轨式工业级 5G 路由器 MIR785R
武汉迈威通信股份有限公司

低功耗广域窄带通信芯片——ZT1826
厦门纵行信息科技有限公司

BG27 蓝牙和 MG27 多协议无线 SoC
深圳芯科技术有限公司

物联网平台 / 云平台 / 云计算 / 边缘计算 / 大数据 / 数据安全相关产品

机智云嵌入式操作系统边缘设备管理平台
广州机智云物联网科技有限公司

高性能可拓展数传边缘网关
济南有人物联网技术有限公司

分布式多模数据库 KaiwuDB
上海沄熹科技有限公司

To B/G 应用智能终端产品

5G LoRaWAN FBL800
福建省四信数字科技集团有限公司

M80J 加固平板电脑
深圳市亿道信息股份有限公司

零碳乡村煤改电智慧暖通终端 SL-CAT-DDR
杭州速利科技有限公司

To C 应用智能终端产品

智能穿戴设备 i37 Ring2
广东壹健康健康产业集团股份有限公司

XP-T503 云打印出餐一体机
珠海芯烨电子科技有限公司

IoT 综合应用类产品

AIRIOT 智慧系统搭建平台
航天科技控股集团股份有限公司

英飞凌 PSoC ™ 4000T 系列微控制器
英飞凌科技股份公司

32 位 CPU 物联网安全芯片 HSC32I3
北京宏思电子技术有限责任公司

智慧用电 / 能耗监测 / 多媒体设备综合管理系统
厦门南鹏物联科技有限公司

物联之星 IoT Star Awards

2023 年度中国物联网行业标杆案例榜

智慧城市应用案例

西南地区电力架空线路智能巡检项目
北京智芯微电子科技有限公司

国内小型水库雨水情测报和大坝安全监测设施建设与运行项目
基康仪器股份有限公司

河南洛宁智慧城市视频系统建设项目
北京嗨动视觉科技有限公司

北京智慧热力远程监控项目
北京昆仑海岸科技股份有限公司

广州 TPUNB 用电安全智能监管系统应用项目
广州披象科技有限公司

杭州 OPPO 全球移动终端研发总部大楼精细化管控项目
杭州宇泛智能科技有限公司

驻马店市智慧消防物联网项目
河南力安测控科技有限公司

湖南物联网感知平台应用建设项目
深圳市聚诚天下科技有限公司

长沙市城域物联网管理平台应用项目
深圳市有方科技股份有限公司

珠海市高新区城市物联感知平台应用项目
珠海市旗云科技有限公司

智慧能源应用案例

三峡时代车载电池采集系统
米态互联（厦门）科技有限公司

山西铝业「皮带传输智能视频监控系统」
山东极视角科技股份有限公司

中国铁塔基站储能项目
深圳富视安物联科技有限公司

倍联德 E527-S6NT 助力陕西煤矿开采智能化改造项目
深圳市倍联德实业有限公司

华东地区宁水智能水表项目
中移物联网有限公司

智能工业应用案例

四川宜宾纺织产业园边织边检产线智能化改造项目
广州机智云物联网科技有限公司

国内智慧工业管理平台应用项目
杭州芯博士网络有限公司

滨州市愉悦家纺 5G 智慧工厂
联通数字科技有限公司

深圳移动边缘计算智能多载体云柜项目
日海智能科技股份有限公司

鲁丽智慧工厂数据平台建设项目
山东有人智能科技有限公司

江苏周转箱 RFID 管理应用项目
上海英内物联网科技股份有限公司

东莞某著名手机智能终端企业 - 车间生产设备定位盘点管理系统应用
深圳空循环科技有限公司

RFID 工业识别在湖南新能源电池生产中的应用
深圳市万全智能技术有限公司

福建可门电厂燃煤电厂输煤系统人员安全防护项目
郑州联睿电子科技有限公司

智慧园区应用案例

5G 模组 SRM815 助力新石器无人车火爆进博会项目
美格智能技术股份有限公司

北京某实验室 UWB 室内定位系统项目
深圳华云时空技术有限公司

湖南怀化动态无感知智慧校园项目
深圳市华夏纵横安防科技有限公司

杭州亚运村未来社区项目
深圳市润腾智慧科技有限公司

智能交通应用案例

深圳交通物联网连接管理项目
深圳前海翼联科技有限公司

贵阳共享电动车文明出行应用案例
深圳市泰比特科技有限公司

深圳城域物联专网精细化治理应用
深圳市智联城市通信有限公司

智慧物流应用案例

劢微机器人打造甘肃省「冶金行业」一体化智能物流项目
劢微机器人科技（深圳）有限公司

SENSE-HW100 ITC Cloud 知名企业器材仓 RFID 云管理系统项目
深圳市先施科技股份有限公司

智慧医疗应用案例

北京科兴 RFID 固定资产管理项目
常达智能物联（深圳）有限公司

上海某精神科门诊蓝牙 AOA 室内定位系统项目
蓝色创源（北京）科技有限公司

上海医疗供应链 RFID 智能仓储管理项目
上海中卡系统集成有限公司

深圳某大型医疗被服租赁系统项目
深圳市勤业物联科技有限公司

上海市具备医学价值的动态健康监测项目
自连电子科技（上海）有限公司

新零售应用案例

中国地区快时尚品牌 UR RFID 智慧门店应用项目
保点贸易（上海）有限公司

助力全球知名零售商迪卡侬溯源数据精准高效采集项目
深圳市远望谷信息技术股份有限公司

广东清远电信 3C 门店 ESL 电子标签智慧显示项目
深圳云里物里科技股份有限公司

福建厦门某茶叶集团茶叶管理系统项目
厦门信达物联科技有限公司

智能人居 / 康养应用案例

山东淄博智慧社区数智居家养老项目
杭州宜优居物联网科技有限公司

智慧养老 - 河南新乡老年公寓管理中心项目
精华隆智慧感知科技（深圳）股份有限公司

广州 CBD 五星级某酒店新风系统改造项目
盈电环保节能科技（广州）有限公司

智慧农业应用案例

南安市数字乡村振兴服务平台应用项目
福建拾联乡村产业发展有限公司

其他应用案例

新疆天池能源将军戈壁二号露天煤矿室内外一体化人员定位项目
杭州品铂科技有限公司

杭州绿色节能建筑建设项目
厦门星纵物联科技有限公司

广州 + 智慧矿山管理平台应用项目
深圳市艾赛克科技有限公司

西藏智能烟火探测摄像机应用项目
英特灵达信息技术（深圳）有限公司

![物联之星 IoT Star Awards] **2023 年度中国物联网行业卓越人物榜**

陈德龙
上海铭控传感技术有限公司 总经理

甘泉
深圳市先施科技股份有限公司 副总经理

何辉
上海道生物联技术有限公司 CEO

廖荣华
上海移为通信技术股份有限公司 总经理

陶建辉
北京涛思数据科技有限公司 创始人 &CEO

王华清
上海移柯通信技术股份有限公司 CTO

魏可伟
上海沄熹科技有限公司 首席技术官（CTO）

肖建宏
芯翼信息科技（上海）有限公司 董事长 &CEO

郑凛
广州技象科技有限公司 高级副总裁

周剑明
中国联合网络通信有限公司深圳市分公司 总经理

AIoT库
www.iotku.com

AIoT Ku sincerely invites you to join for free

- 2000+/year industry direct procurement information
- 80000+/year industry bidding information
- 900+AIOT listed company information
- 30000+ system integrator information/contacts
- 60000+ enterprise network resource docking

Free joining, enjoy service

- Product release
- Solution release
- Industry bidding
- WeChat community
- Network introduction
- Industry activities
- Enterprise display
- Find product
- Find solution
- Industry report

Scan the code to follow → 1

The bottom menu → 2

User registration → 3

公众号 AIoT 库 关注
联网采购，就上AIoT库！

09:37
Hi, 欢迎关注 AIoT 库
平台功能 用户注册 平台服务

提交
*注册需获取您的微信手机号码，
后续可使用手机号+验证码登录AIoT库。

AIOT Ku 100+ supply and demand docking groups are waiting for you to join!

After registering AIOT Library >Add customer service WeChat >
Send business card >Add you to the group after verification

AIoT星图研究院
AIoT Xintu Research Institute — Your IoT Industry Consultant

Based on nearly 20 years of professional accumulation of IoT Media and IOTE Exhibition, 8000+ customers and 50W+ user resources, AIoT Star Chart Research Institute combines professional experience with down-to-earth industry research to bring the most reliable information intelligence to AIoT industry, academia, research and investment.

Service areas: Enterprise information services, IoT industry research reports, enterprise customized industry reports, government customized industry reports

Stay tuned for more reports
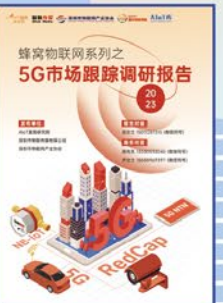
Business docking   **Report download**

Mr.Chen 86-18676385933