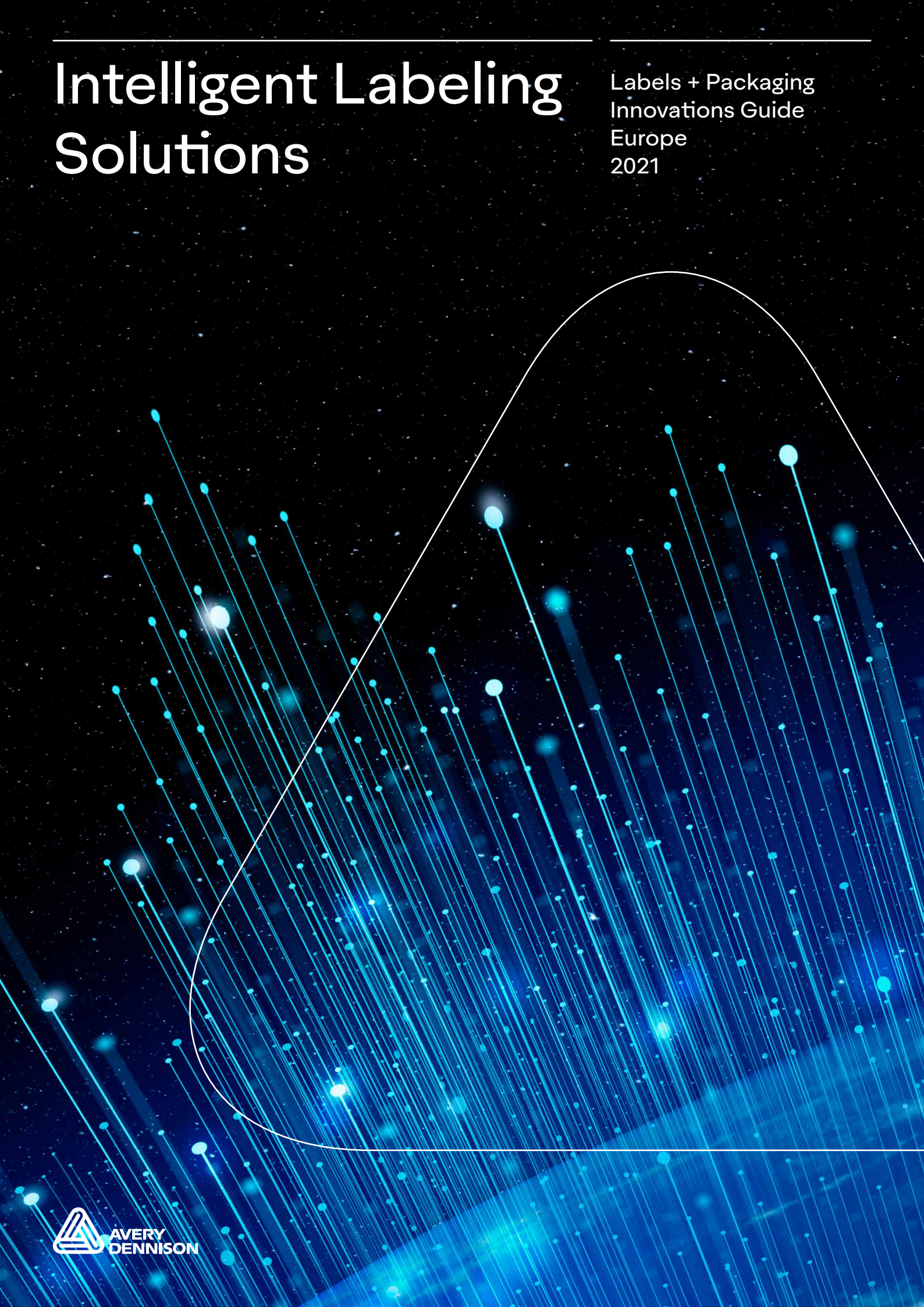
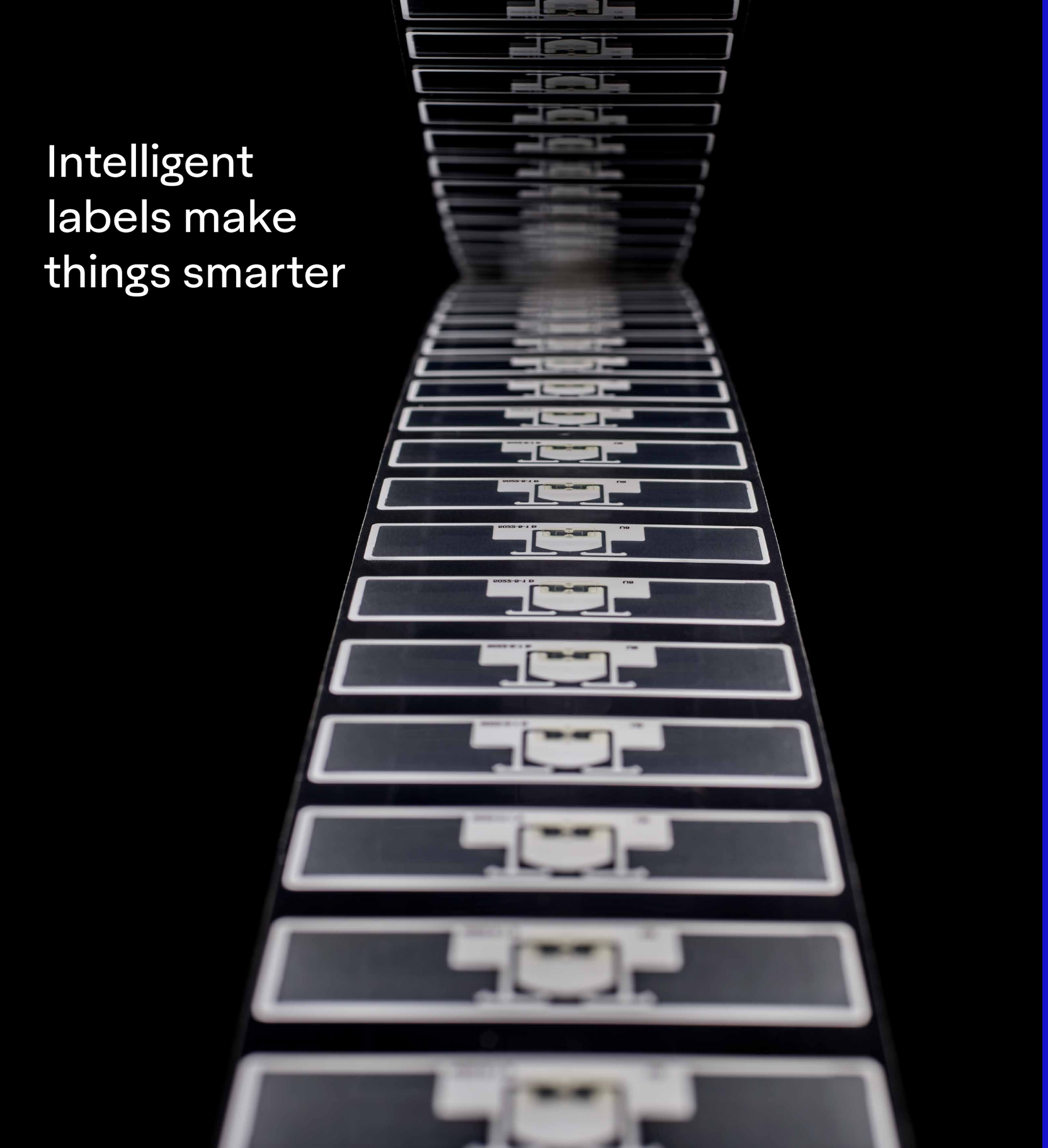
Intelligent Labeling Solutions

Labels + Packaging
Innovations Guide
Europe
2021



AVERY DENNISON

Intelligent labels make things smarter



The physical and digital are integrating like never before. Through the IoT – the internet of things – countless objects are connecting with the online ecosystem, changing the way we work, play and live. At Avery Dennison, we're ready to help you navigate this landscape and enjoy the benefits of our intelligent label solutions.

By infusing everything from clothing to food with a digital identity, these radio frequency identification (RFID) tags can dramatically improve supply chain and inventory management. They're also the key for unlocking richer brand experiences, building stronger consumer relationships, adopting better sustainable practices and more.

We hope to partner with you on this journey to a more connected world and change your business for the better.

Michael Sanders
Vice President, Inlay Sales
and Business Development
Avery Dennison Smartrac

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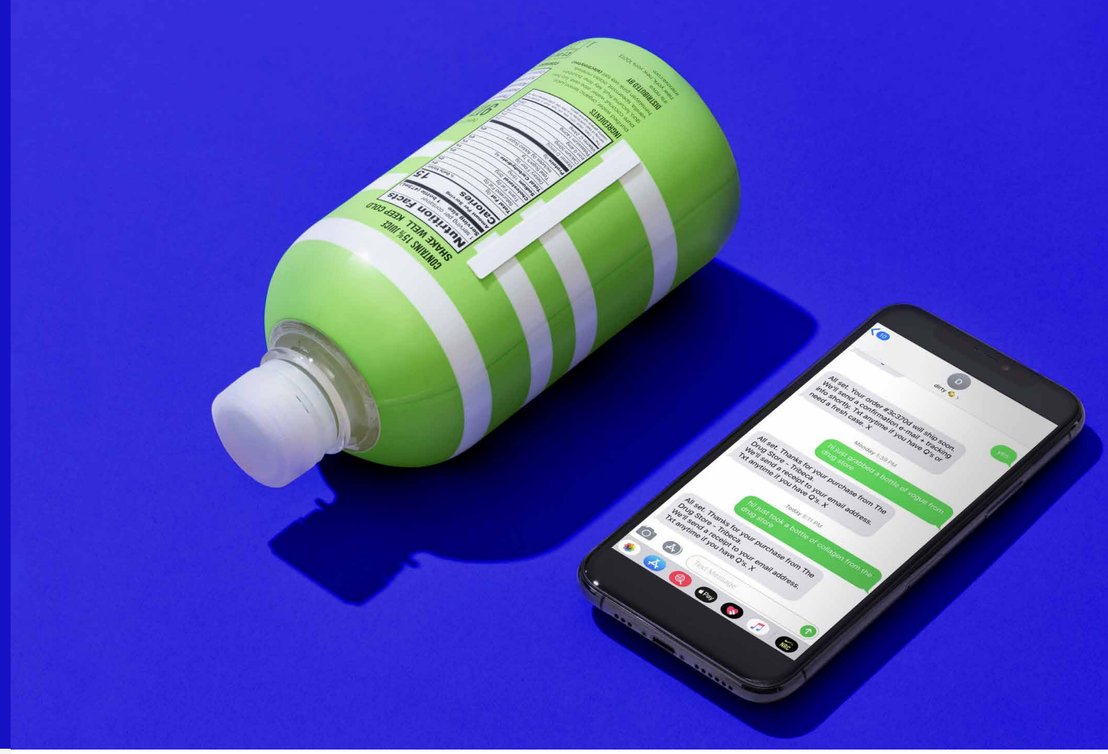
LPM/EU/2021/September

RFID market trends

In labeling, few innovations are as capable of creating monumental change as intelligent labels. RFID solutions bridge the physical and digital, enabling businesses to add connectivity to any item.



Food, wine and spirits

Over 1.3 billion metric tons of food is wasted annually, but RFID technology can reduce this amount, save money and enhance safety. Intelligent labels increase supply chain transparency and help stores monitor expiration dates and returns. They also protect consumers from dangerous counterfeits, a serious challenge for the wine and spirits sector.

Retail

RFID delivers accurate, real-time data, making it popular for apparel retail. By enabling frictionless experiences like self-checkout through ‘touchless’ technology, it makes unmanned stores and smart vending machines possible. It also puts valuable information about sales history, inventory and dynamic pricing within reach.

Healthcare and pharmaceuticals

Intelligent labels can transform healthcare and the pharmaceutical industry through the Internet of Medical Things (IoMT). From inventory management to education, dosing and in-home care, it can help companies follow new regulations focused on transparency while ensuring products are authentic.

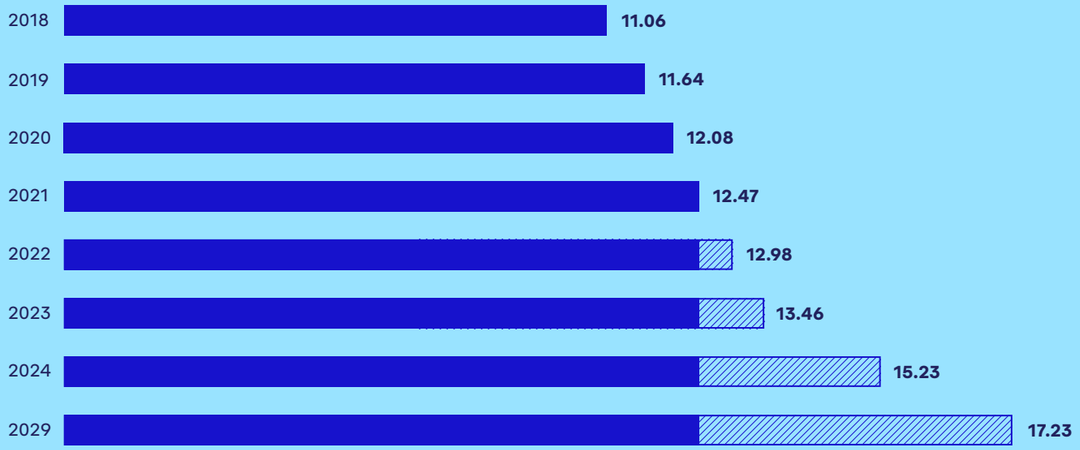
Automotive

Asset tracking and supply chain solutions using RFID improve efficiency for automotive manufacturers hoping to maintain profit margins in highly competitive global markets. The technology increases supply chain integrity, improves safety and reduces liabilities, leading observers to forecast accelerated growth for RFID over the next few years.

Commercial aviation

Commercial airlines are using RFID technology to increase baggage transportation transparency. By reducing mishandled bags by at least 27%, it can save them roughly $3 billion annually. The move to RFID has been a wide-scale collaboration between multiple stakeholders, including airports, airlines, luggage handlers and technology providers.

Market size 2018–2029, $ billions



What is an RFID inlay?

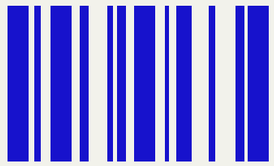
An RFID inlay consists of three parts: the chip, antenna and carrier.

The chip is the brain that stores identifying data while the antenna is the transmitter that relays it from the chip to the reader, and the carrier is the flexible substrate that they are attached to.

In some ways, RFID inlays are similar to barcodes, as they both provide information almost instantly. However, while barcodes use an optical identification process, RFID uses radio waves and antennas to identify and transmit data, allowing you to scan RFID tags without having to see them.

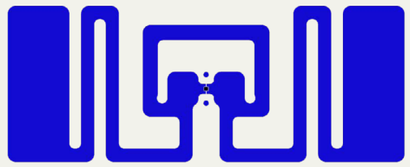
In addition, RFID chips can hold much more information than barcodes, allowing users to track and store multiple types of data.

RFID vs Barcode



Barcode scanning

- Must be visible when scanned
- Provides a limited amount of information
- Can only be scanned by one person at a time
- Scanning can only take place in close proximity



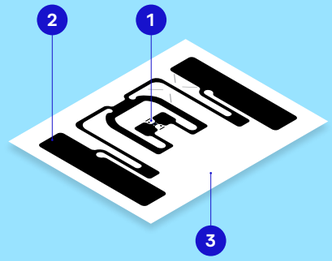
RFID scanning

- Visibility is not required for scanning
- One person can scan multiple tags simultaneously
- Can hold an extensive amount of information
- Can be scanned from several meters away

Unlike traditional alternatives, RFID tags consist of a standard label and a special inlay that delivers added capabilities thanks to three distinct parts: a chip, an antenna and a carrier:

Standard label

RFID inlay

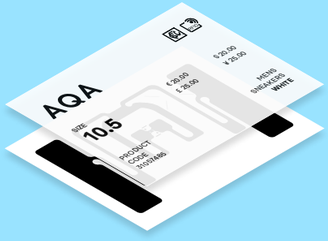


1. Chip
The intelligence of the inlay, which communicates with the reader and allocates memory storage space for specific information

2. Antenna
A conductive geometric device that captures the signal from the reader and sends it to the chip

3. Carrier
A substrate that holds the chip and antenna, which can be made of PET, paper or fabric

RFID tag



Finished ticket or label encasing the RFID inlay

How RFID works

There are three main parts of an RFID system: the tag, hardware and software.

Each tag contains a unique identification number that is read and then linked to product data on a secure database, so every individual item can be identified.

1. Tag
An RFID-enabled label or tag

The RFID tag, which can take the form of a ticket or label, encases the inlay's chip and antenna, which serve as a brain for storing information and a transmitter that allows it to be accessed with a reader.

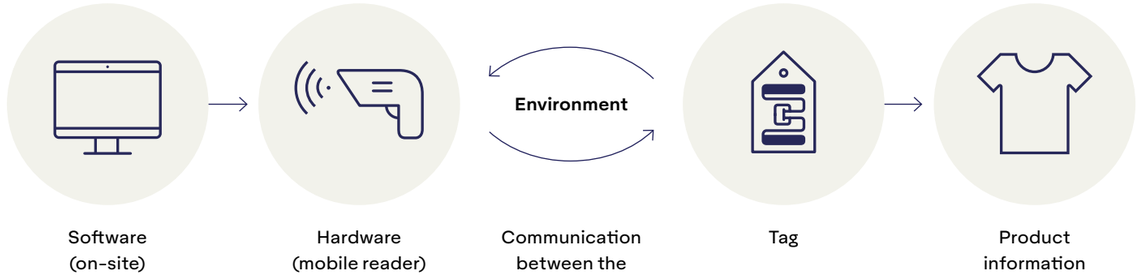
2. Hardware
An RFID reader that can be fixed or mobile

The reader is a fixed or mobile device for accessing chip information and can be used to perform various tasks, including updating inventory and issuing counterfeiting and theft alerts.

3. Software
Processes data from an RFID hardware device, can be located on-site and/or in the cloud

RFID software processes the data that's sent to and received from the reader. There are many kinds of this software, which can focus on everything from warehouse management to asset tracking, and it can be based on site and/or in the cloud.

RFID full system example: passive UHF RFID



Benefits of adoption

RFID offers many benefits, but they all boil down to a few key advantages.

Security

By increasing supply chain transparency and enabling location and inventory tracking, RFID tags help thwart theft, counterfeiting and the misuse of goods.

Engagement

RFID tags help end users meet customer demand for improved in-store experiences as well as engagement after purchasing a product.

Sustainability

Using RFID tags for tracking and inventory can reduce production-related waste and improve efficiencies throughout the supply chain.

> RFID tags offer vast data storage capabilities

Track and trace

To meet global market demand for continuous cost reductions and performance improvements, many end users are turning to RFID tags, which offer vast data storage capabilities and a way to track and store data for diverse market applications.

Compliance

Industries governed by strict compliance rules and regulations, such as serialization and provenance tracking, can use RFID to ensure products meet specific regulatory standards and performance criteria.

Aesthetics

Whereas barcodes use an optical identification process, RFID uses radio waves and thin antennas to identify and transmit data, eliminating concerns about label orientation and line-of-sight obstructions.

A connected world driven by digital platforms

Digital twin

A digital version of the physical product is created

Source

Materials, ingredients, provenance and sustainability

Manufacture

Product provenance, manufacturing performance and shipping accuracy

Distribute

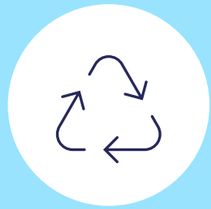
Receiving and shipping, performance and accuracy

Retail

Product availability, inventory accuracy and consumer engagement

Consume and operate

Post-purchase interactions and consumer patterns



Recycle

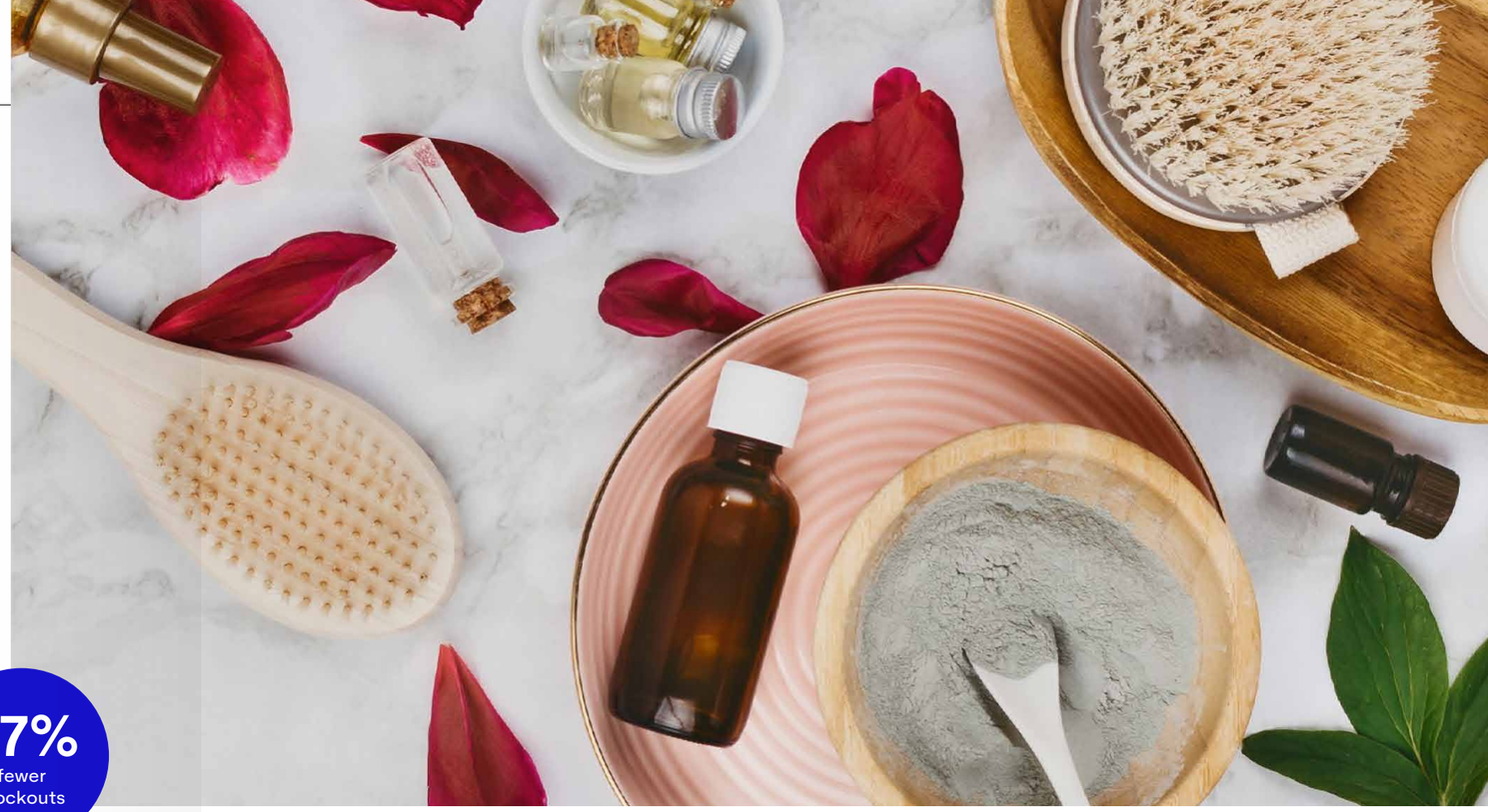
Sustainable recycling, circular economy and secondary marketplaces

Responsibly handled

Appropriate handling at the end of a product's life

Industry examples

With the help of Avery Dennison Smartrac, some of the world's largest multinationals are testing, piloting and implementing RFID technology.



Grupo Boticário

97% fewer stockouts

Pharmaceuticals: **SUKU**

Ensuring instant authenticity verification and supply chain transparency. Avery Dennison Smartrac teamed up with blockchain startup SUKU to develop digital verification for authenticating COVID-19 testing kits and personal protective equipment. The technology ensures end-to-end supply chain transparency, allowing organizations to use real-time data to make informed decisions about allocating doctors, facilities and resources.

Sodexo

Beauty: **Grupo Boticário**

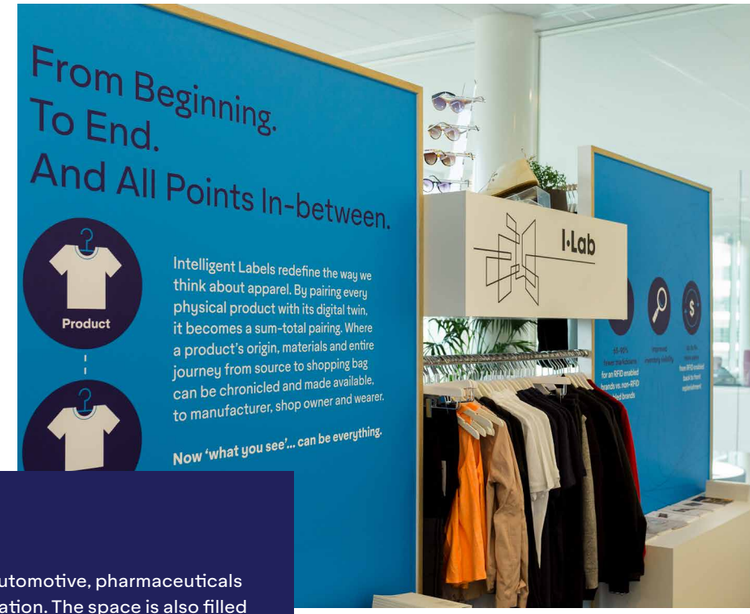
Providing end-to-end traceability across supply chains. Grupo Boticàrio is Brazil's second-largest cosmetics company and the world's largest beauty franchise network. Seeking end-to-end traceability across its increasingly complex supply chain, the company ran RFID tests for six months in 2018. During this period, stockouts dropped by up to 97%, identification of hidden stockouts increased by more than 50%, and revenue climbed. The company is now deploying RFID across one of its brands, with plans for expansion.

Food: **Sodexo**

Enabling automated self-service vending machines. In 2018, food services specialist Sodexo piloted SmartChef, an app for the SmartFridge vending machine, which provides entrees, snacks and beverages. Consumers use the app to scan the fridge's QR code to unlock it and take what they want. Afterward, the fridge analyzes the remaining items using their microwave-friendly WaveSafe™ RFID inlays and determines what was taken so the customer can be billed.

Logistics: **Suar Group**

Cutting costs, saving time and improving accuracy. Construction specialists Suar Group Indonesia needed an asset tracking solution for its large-scale projects that would save time and money. Working with Avery Dennison Smartrac, it began using Midas Flagtag®, a type of durable RFID inlay, and paired it with drone readers. The approach dramatically sped up the inventory process while boosting accuracy, cutting costs and reducing the time required for projects.



I.Lab

I.Lab

The I.Lab is a state-of-the-art experience center that showcases Avery Dennison's capabilities in RFID and intelligent labeling. Offering hands-on experiences, live demonstrations and customer case studies, its interactive displays show how multiple industries can be transformed, including retail, apparel, food, automotive, pharmaceuticals and aviation. The space is also filled with examples of how intelligent labels improve sustainability, enable a circular economy and reduce waste across the entire supply chain.

Visit us here to schedule an appointment

How to choose RFID inlays

Application is the main driver of inlay selection. However, the characteristics of a product, including its composition and dimensions, affect the material requirements, composition and dimensions of its RFID inlay.

1 Determine your requirements

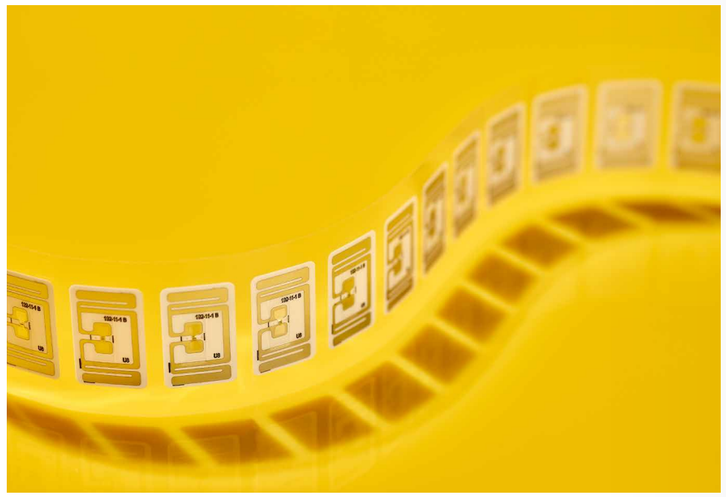
- Item to tag
- Required read point performance
- Chip features needed
- Converted/delivery formats
- Encoding requirements

2 Align your requirements with inlay capabilities

- Review RFID inlay data sheets
- Review inlay certifications

3 Test and validate

- Simulate a real-world scenario
- Ensure performance meets your requirements
- Confirm production and scale capabilities



Common application questions to determine inlay requirements:

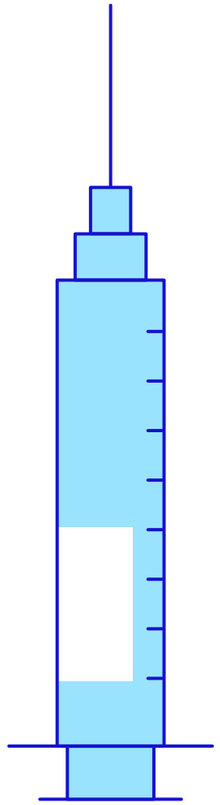
Q1 What is the product made of?
(e.g. glass, plastic, metal)

Q2 Where will the tag be placed?
(e.g. on the syringe, flagged, on the cap)

Q3 Will the product go through any process?
(e.g. sterilization, extreme temperatures)

Q4 How will the RFID inlay be read?
(e.g. handheld or fixed reader)

Example decision-making process:



A1 Made of glass but will contain liquids

A2 Tag will be applied directly on the syringe

A3 No special process, storage temperatures up to -40°C

A4 Near field fixed reader

Inlay selection considerations:

1. RFID tag that performs well near liquid
2. Small enough for the diameter of the syringe
3. Operating temperatures from -40°C to 85°C
4. Good shape for readability of fixed reader

Solution: “Minidose” inlay

Products and solutions

Whether you want to digitize and authenticate products, track items, optimize your supply chain or enhance consumer encounters, Avery Dennison Smartrac's RFID technology portfolio can fulfill your needs.

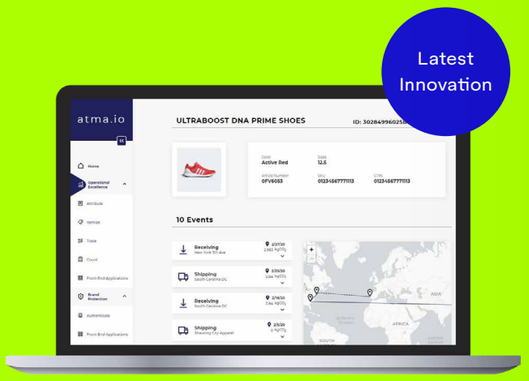
As the world's largest RFID manufacturer, we have the industry's most comprehensive selection of products in the UHF and HF/NFC frequency bands. Expertly manufactured, thoroughly tested and designed for minimal environmental impact, our offerings can be fully customized, broadening their fields of application even further.

Here is a snapshot of our portfolio and latest innovations:

atma.io

A cloud platform that unlocks the power of connected products, atma.io assigns unique digital IDs to everyday items, providing unparalleled end-to-end transparency by tracking, storing and managing all the events associated with each individual product.

- Provides an end-to-end software platform for creating fully connected products
- Suitable for a wide range of vertical markets, including apparel, beauty, food and pharmaceuticals
- Can be used to strengthen brand protection, enhance consumer engagement, improve operational excellence and support sustainability



UHF & HF/NFC inlays

Our RFID portfolio includes inlay designs for operation in the UHF, HF and NFC frequency bands. These designs are found in a range of industries, including apparel, beauty, food, automotive, aviation, healthcare, transport and manufacturing. They are available in a variety of delivery formats and recommended for countless applications with high performance requirements.

UHF inlays
Ultra high frequency (UHF) inlays use a higher frequency band and provide a read range of up to 10 meters, making them ideal for many tracking applications across various industries, from apparel to aviation. They are also an excellent choice when multiple items need to be scanned quickly.

HF / NFC inlays
High frequency (HF) and near field communication (NFC) inlays provide a shorter read range than UHF inlays, though they often have a larger memory and stronger security features. They are ideal for mobile applications like consumer engagement, as most smartphones have NFC capabilities, and can be attached to posters, promotional items and packaging, or embedded in consumer goods and durables. Additionally, their performance is less sensitive to exposure to different materials and environments, including water.

Sustainable inlays

We strive to align our RFID inlays with the principles behind Sustainable ADvantage, our portfolio of eco-friendly products and solutions. Our Life Cycle Assessment process furthers this approach by measuring product sustainability so we can continuously improve. A growing number of our inlays also include SmartFace™ technology, which replaces PET plastic with a paper substrate, and there are additional criteria we focus on as well:

- Increasing the use of FSC-approved and other certified papers, including those made from post-consumer waste
- Continuing to develop products that are free from heavy metals and are made with an increasing amount of recycled content
- Reducing energy consumption and the use of harsh chemicals by avoiding chemical etching, which also allows us to recycle our excess aluminum back into the system
- Using a minimal amount of adhesives in the chip bonding process
- Earning third party recycling certification
- Reducing the amount of liners used to make our products

On-metal inlays

These inlays are designed to have reliable reading performance for tagging on metal and near liquids.

- Developed to solve direct-to-metal tagging challenges
- Suitable for applications related to industrial uses, computers, electronics and consumer goods
- Product applications include beverages like bottled water and juices, as well as soft drinks in aluminum cans

WaveSafe™

WaveSafe™ is the first UHF RFID tag that can withstand up to five minutes of 950-watt microwave cooking, making it perfect for item-level tagging of frozen packaged foods without sacrificing readability or data accuracy.

- Designed to prevent arcing and heat build-up during microwaving
- Safe for accidental microwave use cases
- Compatible with home and commercial microwave ovens

Investing in RFID Technology

As more end users experience the benefits of RFID, demand is growing rapidly. Market-savvy converters who offer RFID capabilities to their customers are gaining a competitive advantage and market share in industries ranging from retail to aviation.

Integrating RFID into the converting process requires investing time and resources, but it's worth the effort. Before taking the first steps, it is important to understand the key players you will interact with in the RFID market.

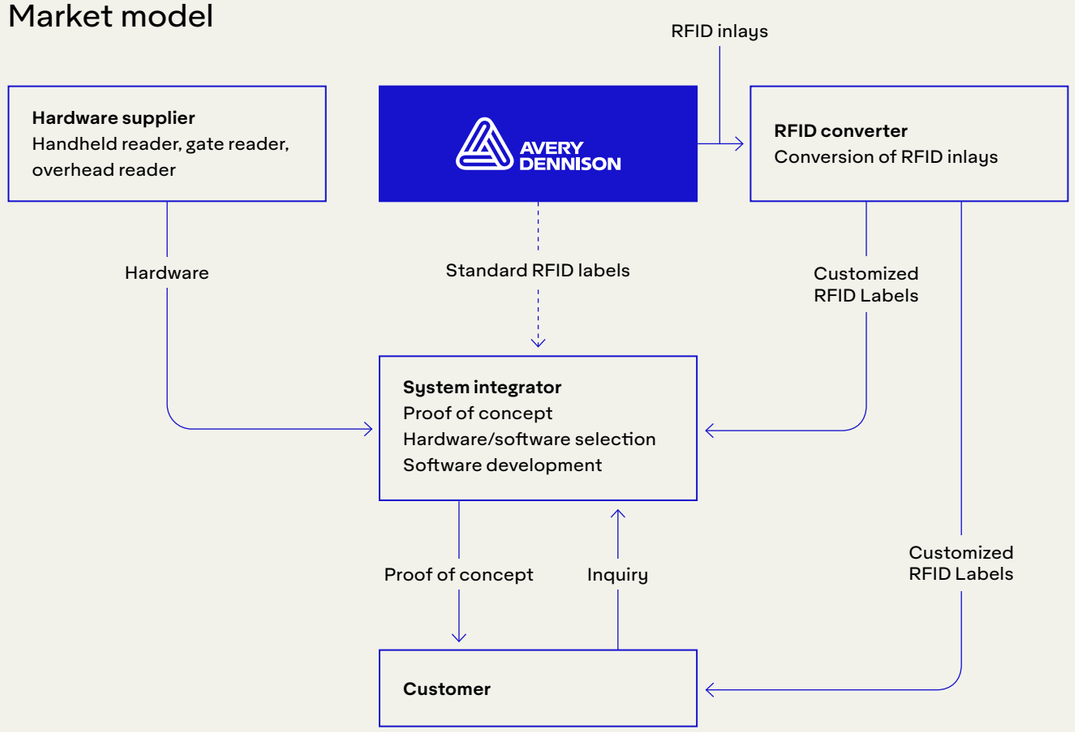
Hardware supplier
Provides the physical readers that will be communicating with the RFID tags and the information on them. Readers come in different shapes, including hand-held mobile devices and fixed versions that resemble a tile and are installed in a warehouse.

System integrator
Provides the software in which the hardware readings of the RFID tags can integrate with the system of the customer. They can work closely with the customers on Proof of Concepts as well as aid in software development.

RFID-enabled converter
Works with the RFID inlays to get them converted in the right size and/or print that the system integrator or customer requests.

RFID inlay supplier
We provide you with the RFID tags and/or inlays that system integrators or RFID converters need to help the customer establish their full RFID system.

Market model



Now that you understand the market environment, there are a few more things to consider if you're thinking about becoming an RFID-enabled converter.

Testing
An insertion process must be incorporated into an existing conversion line along with testing to ensure the electrical functions of the chips are operating properly.

Equipment
New equipment may be needed to integrate RFID capabilities. Requirements will depend on whether the inlay insertions are dry or wet.

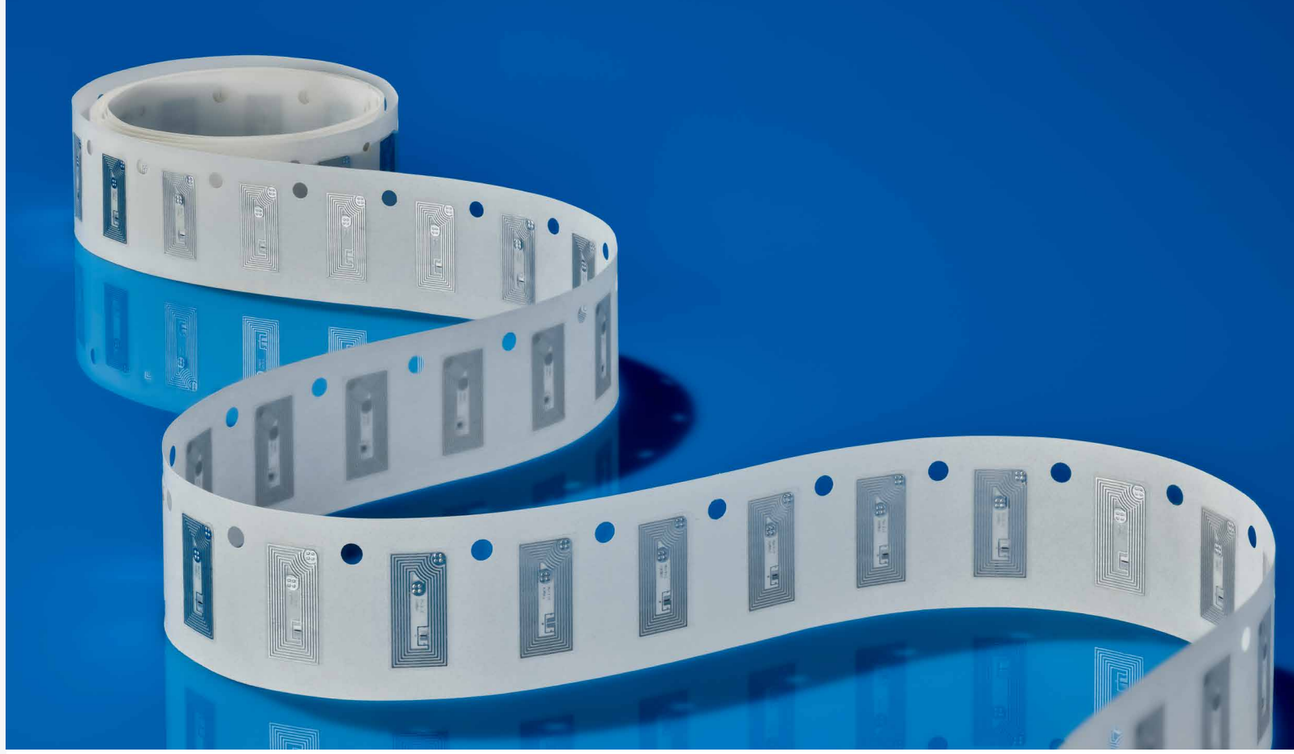
Packaging
Packaging modifications may be necessary to avoid damaging chips during shipping.

Converting RFID

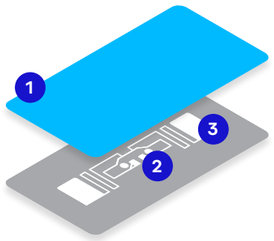
Many converters can continue working with their preferred conversion equipment manufacturer to identify an efficient and scalable RFID solution.

In addition, an experienced inlay supplier can also help identify important components and functions needed to deliver RFID inlays and tags for specific end uses. However, you must decide what delivery format to convert.

There are three main types of inlay delivery formats: dry, wet and label/sticker. Your equipment capabilities and long term goals in the RFID market will influence which one you'll focus on.



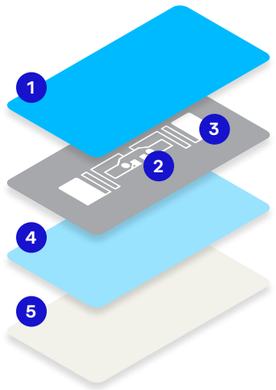
Dry inlay



1. Inlay carrier
2. Chip
3. Antenna

- Paper, film or fabric
- No adhesive
- Unconverted format
- Tight pitch
- Compatible with transfer tapes and gum twins, which add adhesive properties. See our Custom Label Constructions guide for more info.

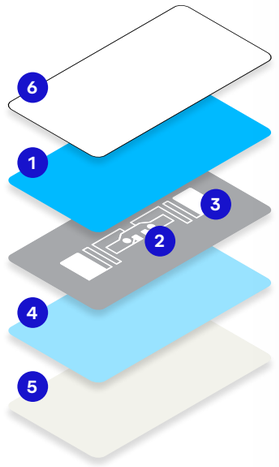
Wet inlay



1. Inlay carrier
2. Chip
3. Antenna
4. Pressure sensitive adhesive
5. Liner

- Paper or film
- Adhesive and liner
- Not intended for printing
- Tight pitch
- Die cut

Label/sticker inlay



1. Inlay carrier
2. Chip
3. Antenna
4. Pressure sensitive adhesive
5. Liner
6. Printable facestock

- Paper or film facestock
- Adhesive and liner
- Printable label
- Die cut
- Facestock can be with our sustainable product Smartface™

Considerations	Inlay type	Conversion	Process
• Mid-high volume orders • Dedicated/more complex • Higher cost of entry	**Dry inlay**	**Off pitch**	**Insertion**
• Mid-high volume orders • Low entry cost • Servo press requirement • Allows custom face stock • <2 inch pitch cost effective	**Dry inlay**	**On pitch**	**Lamination**
• Low-mid volume orders • Low cost of entry	**Wet inlay**	**Off pitch**	**Insertion**
• Mid-high volume orders • Low entry cost • Servo press requirement • Standard print process • Most sustainable	**Label/sticker**	**N/A**	**Resell**

Glossary

Off pitch
Finished tag can be any length, independent of the original inlay pitch.

On pitch
Finished tag must be the same length as the original inlay pitch.

Insertion
Process in which the inlay is inserted below the facestock of the finished label.

Lamination
Process in which the inlay carrier is used as the facestock for the finished label.

RFID converting process

RFID capability can be integrated into an existing label conversion process with the addition of an insertion module.

Depending on quality control and throughput demands, a more extensive equipment upgrade may be required. Let’s take a look at a wet inlay conversion process:

1. Delamination
First, the self-adhesive stock is delaminated by separating the liner and the facestock

2. Inlay inspection
Each inlay is read and verified individually before insertion, though this step is often optional, depending on the insertion module

3. Insertion
The individual inlays are dispensed/inserted onto the release liner to match the final product pitch

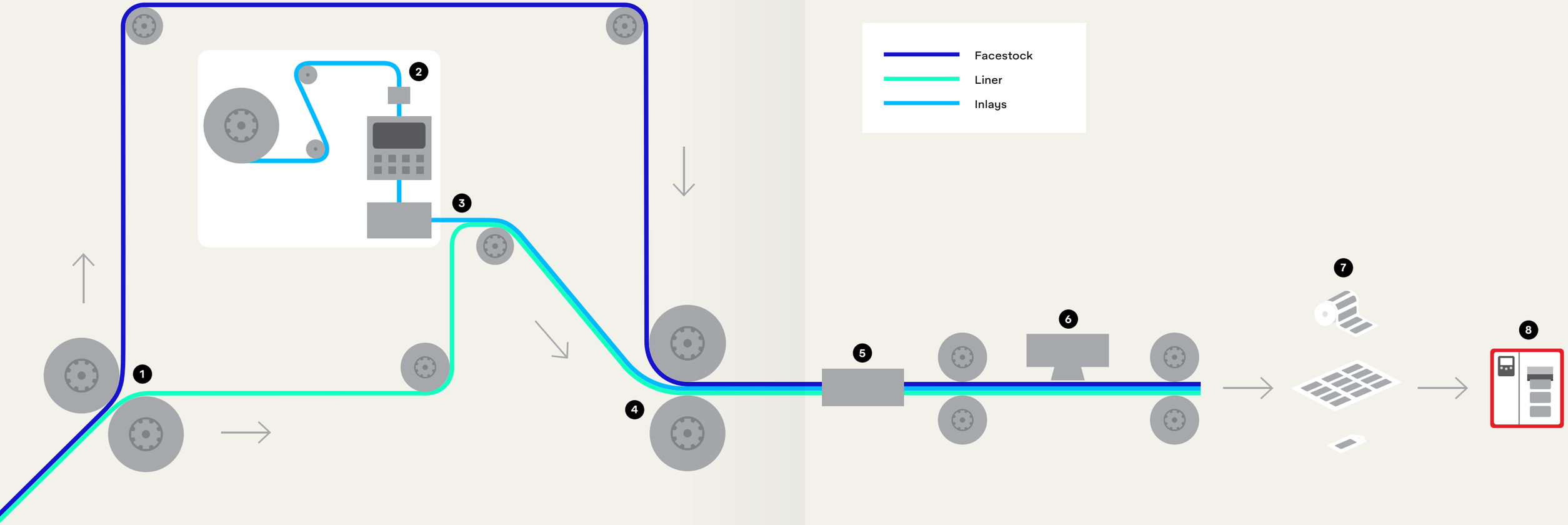
4. Lamination
The face material is laminated onto the top of the inlays

5. Die-cutting
The laminated material is die-cut in register with the inlays as a standard conversion process

6. Testing and marking
Each tag is individually tested for quality and accuracy as part of end-of-line readability verification. Any defective tags are marked, and depending on the converter process, typically replaced during a second stage

7. End product format
The end product can be converted into rolls, sheets or finished products, such as labels and tags

8. Printing and encoding
The finished RFID tag/label can be programmed and encoded with the required information, which can take place during the imprinting process or separately



Is now the time to invest?

RFID is transforming the label conversion process. If you're considering making an investment, there are a few things to think about.

How to choose the right supply partner

The key to developing a successful intelligent labels business is choosing the right inlay provider. Consider these factors:

Portfolio size

Product portfolio size is crucial when selecting an RFID supplier, as you need tags with inlays that work on many items. Avery Dennison Smartrac offers the market's largest array of RFID inlays, including NFC and passive HF and UHF options, as well as multiple inlay sizes, shapes and features.

Quality control

In a production run, some RFID tags can have a short read range or be completely dead due to a defective chip or another issue. Our extensive quality control processes ensure excellent product performance and prevent defective tags from reaching customers.

R&D and technical support

Always work with a provider that can help you select the best tag for your needs and advise on placement of the finished label. Avery Dennison Smartrac tests product samples in a lab that simulates the setting they'll be used in, allowing us to determine the ideal inlay and positioning. If there is enough demand, we can also develop custom tags and labels for our partners at no extra charge.

Sampling and capacity

We can usually provide sample tags within 48 hours, making it easy to get them to customers who are interested in RFID. Once a sale is made, you also need access to a tag provider with the manufacturing capacity required to quickly deliver your order. We have the global distribution needed to make this happen, whether you are in Europe, Asia, North or South America or somewhere else.

LPM/EU/2021/September

How to get started

Integrating RFID into your business is easy when you use our five-step plan. With our support, products and technology, you can increase speed, accuracy, visibility and productivity across your company. Everything from monitoring inventory to helping customers connect with products becomes simpler, delivering unexpected benefits.

1 Business case

We help you develop a bespoke ROI plan for your business and clearly outline the next steps in the process.

2 Custom solution

Acting as your partner, we customize your RFID solution and connect with external partners for support when needed.

3 Pilot process

Using our extensive experience, we will help you establish KPIs for monitoring the benefits you can expect from implementing RFID, allowing you to gauge your progress.

4 Initial rollout

We assist with employee training, change management, initial tagging and compliance monitoring.

5 Full adoption

We will support you during the final rollout and help with any challenges you may experience, ensuring things run smoothly.

A note on sustainability

At Avery Dennison, we take our commitment to the environment seriously, and this extends into our RFID inlays. Sustainability is holistic and includes the way we engage with stakeholders and extends into responsibly sourcing materials, our relationships with the broader ecosystem, the products we create and the ways our solutions can help our customers to become more sustainable.

Doing business sustainably – and growing while reducing carbon emissions and other pollution – is now mandatory for companies by means of regulations and consumers who want to know their purchases do not harm the planet. Our production methods require fewer natural resources, and we use materials that have a smaller impact. Manufacturing waste is recycled to the fullest possible extent, and we avoid conventional etching, which requires caustic chemicals. We focus on continuous improvement for our sites through third-party certification and reducing emissions, water consumption and waste. We also abide by our Responsible Sourcing Policy and Restricted Substances list, and work with organizations like EcoVadis and the Carbon Disclosure Project.

Through it all, our products remain our focal point. SmartFace™ technology and other sustainable enhancements result in items that are virtually plastic-free. We are also increasing the use of certified materials and recycled content, helping to dramatically reduce the carbon footprint of the products we deliver to customers.

Sustainability and RFID technology extends far beyond these measures, however. Giving products a digital identity can reduce waste and improve transparency across sectors, including food, apparel and beauty. Quickly scanning a tag can provide a consumer with the information needed to recycle a product or tell a store manager when food will expire, allowing them to formulate a plan that prevents it from going to a landfill. RFID also allows us to reduce waste by enabling the adoption of reusable packaging and increasing the amount that gets recycled.

As always, we are keeping an eye on the future and pursuing innovations that will further strengthen and enhance sustainability at every level.

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Avery Dennison: your partner for intelligent labeling solutions

With our unique combination of materials expertise, end-to-end technology and global capacity for supporting customers, Avery Dennison Smartrac is shaping the future of multiple industries by showing how to experience the benefits of giving nearly any item a unique digital identity.

Who we are

At heart, we are a materials science company. We specialize in designing and manufacturing a diverse range of labeling and functional materials and have sophisticated engineering skills. A unique combination of expertise and global scale allow us to provide customers around the world with innovative, sustainable and intelligent solutions that include RFID labeling.

What we stand for

In 1935, we invented the first self-adhesive label, and we've never looked back. With each passing decade, our innovations have further shaped our industry by expanding the limits of what labels can do. The world's most successful brands know that innovation and evolution are the lifeblood of longevity and success. We're proud to help our clients continually push the boundaries of what's possible.

Work with us

You're the expert in your business and we're the expert in intelligent labeling. Contact your business development manager today to find out how Avery Dennison intelligent labels can meet and exceed your needs.

label.averydennison.com

Avery Dennison Corporation (NYSE: AVY) is a global materials science company specializing in the design and manufacture of a wide variety of labeling and functional materials. The company's products, which are used in nearly every major industry, include pressure-sensitive materials for labels and graphic applications; tapes and other bonding solutions for industrial, medical, and retail applications; tags, labels and embellishments for apparel; and radio frequency identification (RFID) solutions serving retail apparel and other markets. Headquartered in Glendale, California, the company employs more than 32,000 employees in more than 50 countries. Reported sales in 2020 were $7.0 billion. Learn more at www.averydennison.com.

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