

Abstract

Modern ID cards are required to stand up to many types of stress, ranging from attempts at physical alteration, to wear and tear as well as inconsiderate handling in a variety of environments and weather conditions.

With a lifecycle of up to ten years, national ID cards have always been designed and manufactured on the basis of the highest standards in the smart card industry. The international card industry, together with various standardization bodies and government agencies, has developed and defined standards and certification levels, which have been adhered to for decades.

However, the way that citizens access public and private services has changed dramatically in the last years. Digitization has become a part of nearly every industry sector and a majority of service offerings are now made available online. Smart cards are a popular choice to securely access such services, be it public transportation, payment, medical or social. More often, therefore, governments chose to add additional functionalities to their national ID card schemes.

For government and issuing authorities, adding multiple applications to electronic ID cards translates into more frequent usage. Rather than only using the ID card for verification at a border crossing or for registration purposes, a multi-application card will be used on a daily basis. For the smart card industry this means the card has to be even more robust, durable and secure than ever before, while also bridging the gap between traditional and modern use case scenarios.

Infineon's packaging innovations are designed to increase the durability and robustness of any kind of smart card while at the same time reducing cost for the manufacturer.

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Dual interface technology – a bridge between traditional and next generation use cases

There are a variety of smart card formats in use today. Contact-based cards contain a chip within a visible module and need to be inserted into a card reader, for example at an ATM machine or at a standard payment terminal. Contactless cards, on the other hand, use an embedded chip and antenna to communicate with the reader and are simply tapped against a contactless terminal, for example at public transportation gates. There are also hybrid cards that contain both contact-based and contactless chips as well as dual interface cards, where one chip supports both communication modes, independent of the interface used.

In terms of worldwide implementations, contactless schemes are on the rise. Driven by the payment sector

and strongly invested in by industry giants such as Visa and Mastercard, the tap'n'pay convenience of contactless schemes is growing at a remarkable speed. Countries without a smart card legacy often leapfrog directly to fully contactless governmental applications.

When it comes to multi-application government schemes, the challenges are of a different nature. Infineon believes that a dual interface model is the best solution to address the upcoming multi-application-on-card scenario. Dual interface cards have the benefit of supporting all existing standards and are therefore able to bridge contact-based infrastructures and modern contactless systems.



Complexity and cost of dual interface card manufacturing

In general, when producing dual interface cards, new processes and production methods increase the complexity of card manufacturing which, in many cases, will lead to increased production costs and potential yield loss. A rough factored equation on cost associated with different card productions published by Eurosmart showed that the complete cost of a dual interface card can be 50-70% higher than the cost of production of a contact-based card.

The key contributors to this high cost are often investments in new interconnect machinery, consumables for the connection, yield loss during the dual interface process and the cost of the additional antenna. While some of this cost is mandatory, Infineon's innovative Coil-on-Module packaging technology helps to keep the overall investment much lower.

A standard card body production consists of the collating of various sheets of polycarbonate (e.g. 50 μm and 100 μm thick) which are laminated together resulting in a 760 μm +/- 80 μm (ISO 7810) thick sheet from which the individual cards will be punched out, before an optical inspection finalizes the card body production process.

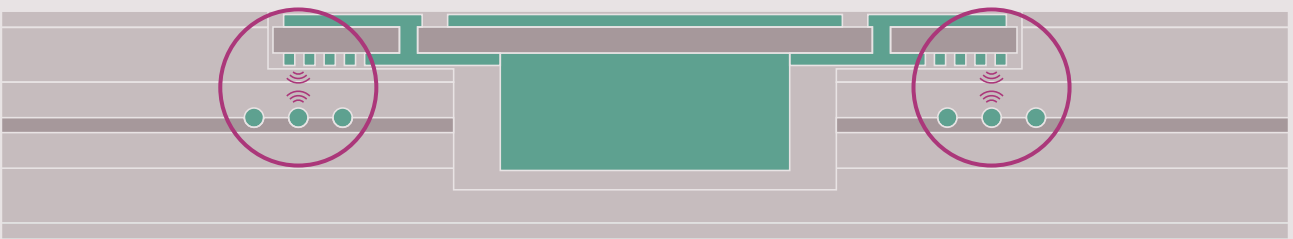
When producing contact-based cards, the chip module needs to be implanted into the card body. Therefore, a milling process forms a cavity in the card body to accommodate the module. The hot melt glue used to attach the module into the cavity is applied to the back surface of the module before it is placed into the cavity itself. The hot melt glue is then activated using heat and pressure to enable proper fixing.

When producing a dual interface card, the additional card antenna needs to be on one of the polycarbonate sheets when they are collated. The most challenging aspect of dual interface card production is connecting the card antenna to the module. The connection needs to be done to the back surface of the module during the implanting process.

Infineon has developed its Coil on Module system, based on inductive coupling, to reduce the cost of dual interface card production. Unlike other methods for incorporating dual interface antenna connectivity, such as flexible bump, conductive adhesive, or soldering, inductive coupling uses electromagnetic waves for connection between the module and the antenna. Similar to the way a contactless card communicates with a terminal, a small antenna on the chip module connects to a coupling area on a standard size antenna in the card, using an electromagnetic field within the card body. This lack of mechanical galvanic connection with no soldered or welded connection ensures that there is no chance of breakage between module and antenna – a huge advantage for a card with a ten-year lifecycle.

Infineon's Coil on Module packaging process allows the skipping of the complex connection process at dual interface card production, leading straight to the module being implanted into the card. Without this production process there is no need for further investments in machinery or consumables, nor are there any additional yield losses. For the card manufacturer this means considerable savings, bringing the additional cost of migrating from contact-based to dual interface from 50-70% down to 30-50%.

Infineons Inductive Coupling Technology removes the weak link!



Packaging technology for polycarbonate cards

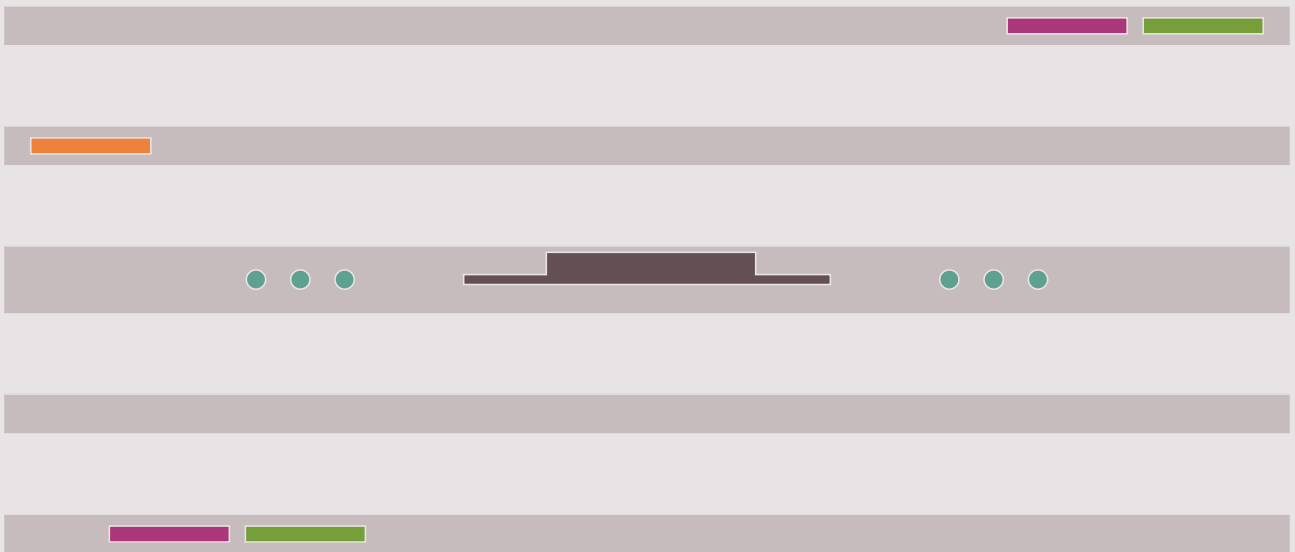
When looking at making a smart card more tamper resistant, it is essential to look at the card body and what it is made of. Polycarbonate, due to its unique properties, has won the trust of governments as the material of choice for durability and tamper resistance. A so-called 'Polycarbonate Monoblock' consists of 'top to toe' polycarbonate, which connects to one block during the lamination without any chance of delamination. After the lamination process, the individual layers can no longer be identified, providing improved robustness and an increased tamper resistance.

During the production process, it is crucial to adhere to the element of a secure 100% 'Polycarbonate Monoblock' even when introducing additional items such as security features or antennas: Having a wired antenna on Polycarbonate continues to support the 100% Monoblock concept. It keeps the existing card construction, as only the wire is inserted onto one of the existing polycarbonate layers and prevents a change of the lamination process, as no new material is brought into the card itself.

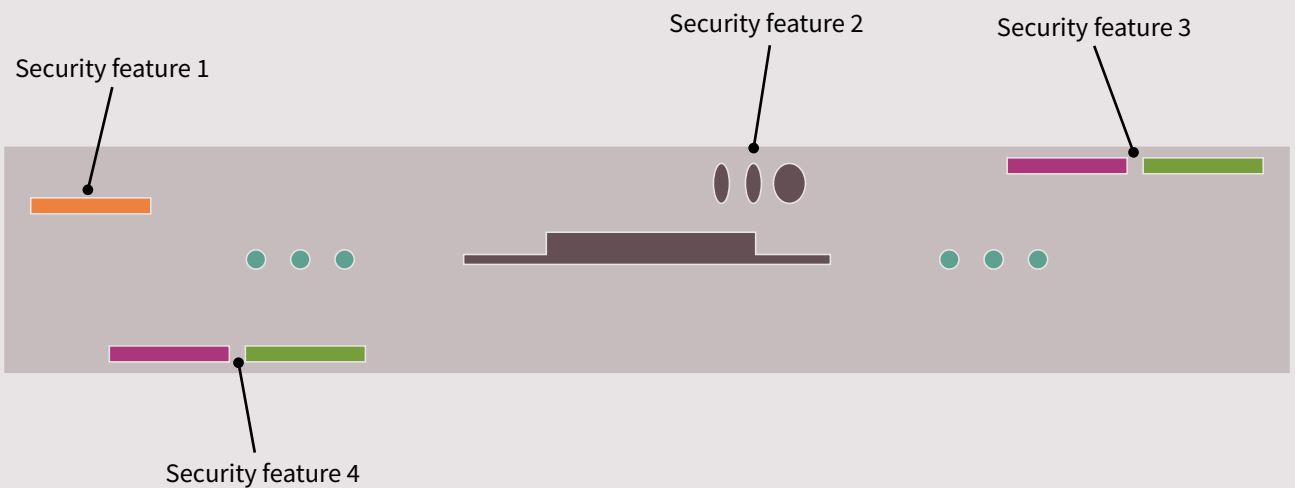
Infineon offers copper wire antennas that can be integrated into any card material, thereby supporting companies who are pushing a solid Monoblock as an anti-tampering method.



From individual layers ...



... to a PC monoblock where the separation between the individual layers vanished



Higher security with lean packaging technology

Increasingly, security designs for national ID cards use the card body and its layers as an enhanced security feature. With transparent layers on both sides of the card the remaining thickness for the module cavity depths shrinks reasonably.

The module from Infineon is very lean at 420µm (30% less than the competition) and supports increased use of transparent layers as a security feature and enables new card constructions that require shallower cavity milling. In a worst case too deep milling could end in the transparency layer that holds the offset print and hologram patch and would result in the module being visible from the outside of the card. With the lean Coil on Module the cavity, depth can be substantially reduced allowing a complete coverage of the module back surface within the opaque area of the card.

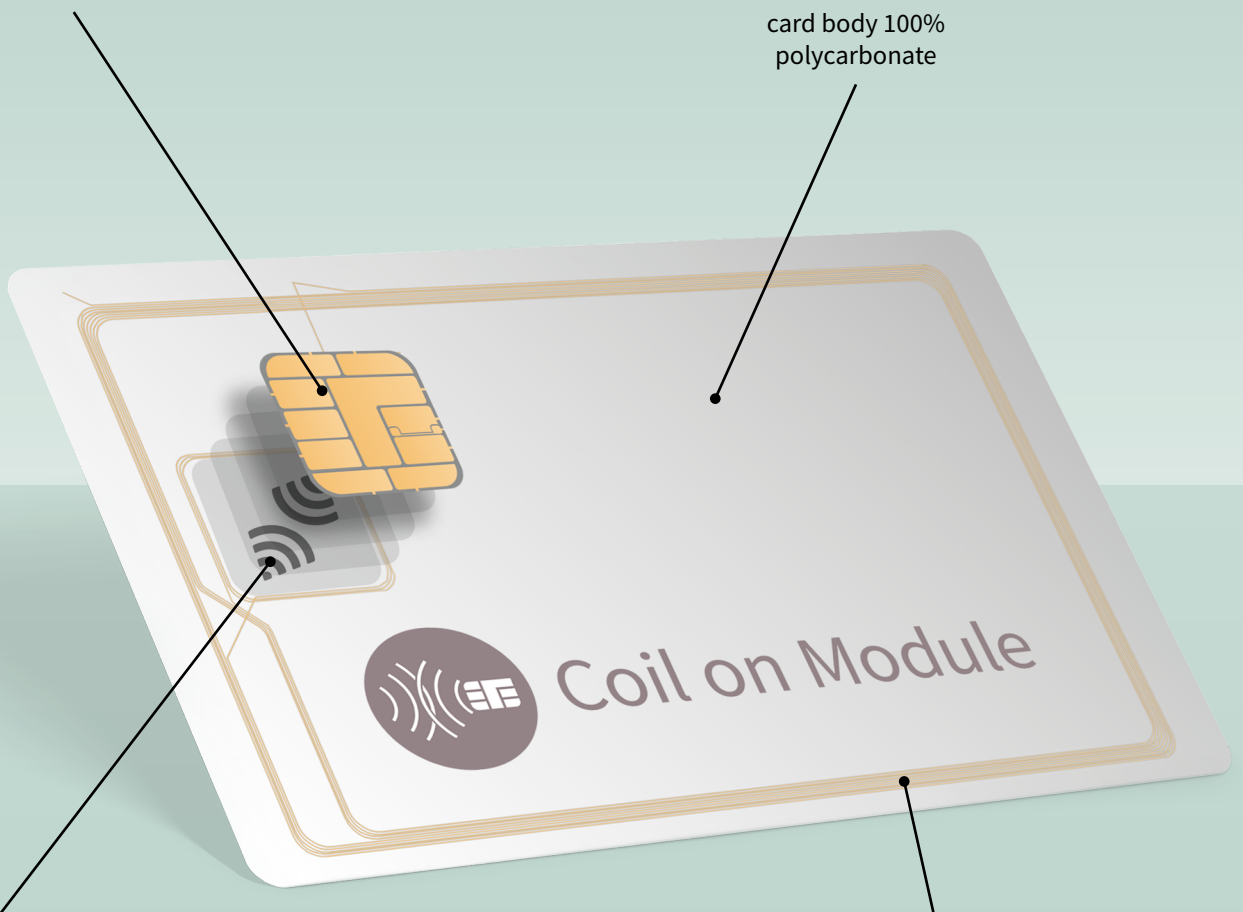
Under the currently used test for card robustness e.g. ISO 10373 specifications, only 8 Newton are required for the 3 wheel test, or just 1,000 bending's and torsions, whereas the industry agrees on at least 4,000. However, up to 8,000 are much more representative for Government ID applications.

There are other bodies providing robustness specifications like the Mastercard Card Quality Management (CQM) for contact-based and dual interface cards. Although the CQM specification originated in the payment industry, governments now also use it.

CQM recommends that in order to survive hard-use cases, the cards and modules should survive a pressure of 15 Newton at the 3 Wheel Test. This advanced, recommended specification is difficult to reach with current standard technologies. With Infineon's flip-chip technology used for the Coil-on-Module, even the 15 Newton can now be achieved. This in itself goes some way to meeting the 10-year hard usage goals required by government bodies.

“Coil on Module” – chip module
with antenna at the rear-side
of the module

card body 100%
polycarbonate



radio frequency communication
between card antenna and
chip module antenna

wired card antenna

Preparing for a pure contactless future: Infineon's INLAM packaging portfolio

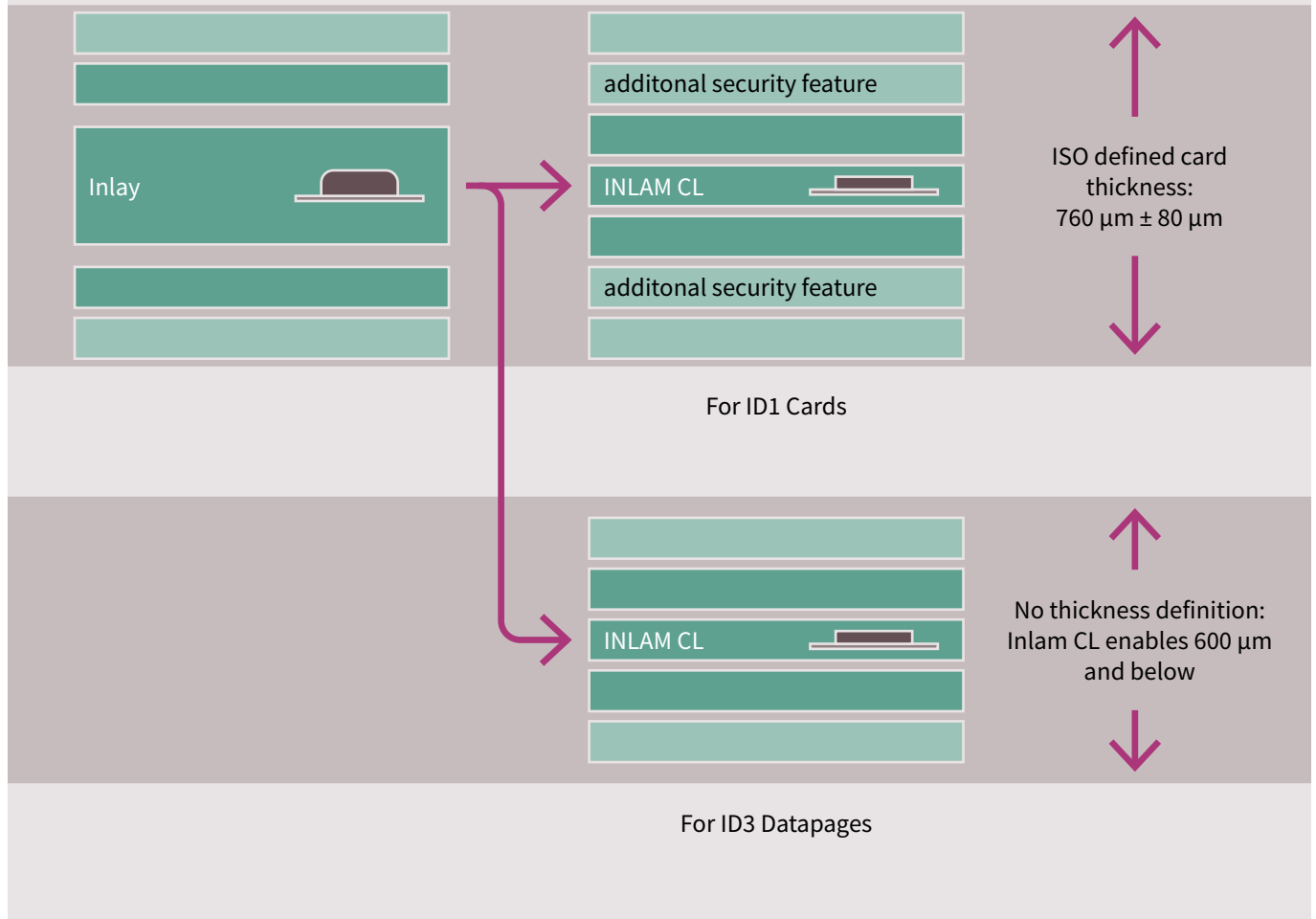
There are a variety of sources for standard contactless inlay solutions using different production processes like thermo compression welding, conductive paste and bare die flip chip – each having their advantages and disadvantages when taking into consideration the required ten-year lifetime of the card. Infineon's Coil-on-Module technology eliminates the galvanic mechanical connection between module and antenna, thereby eliminating a major weak point.

On the other side there are an increasing number of additional security features, such as advanced holograms, UV printed layers, metal stripes and watermarks all of them require to be placed into the card itself while keeping the maximum card thickness of 840µm specified by the ISO. This leaves less space for the Inlay/chip module. For standard thermo compression welding, the copper wire is "guided" over a part of the chip module and herewith limits a minimum thickness. For the Inlam CL the wire is laid around the module, which in combination with a module thickness clearly below 150 µm opens the way for very thin version of Inlays which Infineon calls "Inlam CL".

So while the standard thickness for an inlay is currently 320 µm, with its inductive coupling technology Infineon now has a roadmap for contactless inlays to 250 µm giving the end card manufacturer much greater flexibility. This is an attractive argument for passport manufacturers as they look to reduce the thickness of the data page that carries the chip. Current data pages are standard 800µm, some are at 650 µm, with the goal of reducing the thickness to 600 µm and below. With standard CL module technology as it stands today a further reduction of the Inlay thickness is very limited. Solutions such as the Coil-on-Module on the other open a way for thinner Inlam CL.

Beyond the innovative technology, there are additional benefits with the process flow: Before, manufacturers had to purchase the modules from one supplier and then shipped them to another company for programming and finally ship to the inlay manufacturer. With Infineon managing the entire inlay supply cycle; it can now handle all these aspects of production resulting in a single customer supply point and shorter lead times for the card manufacturer.

Thickness reduction offers two paths



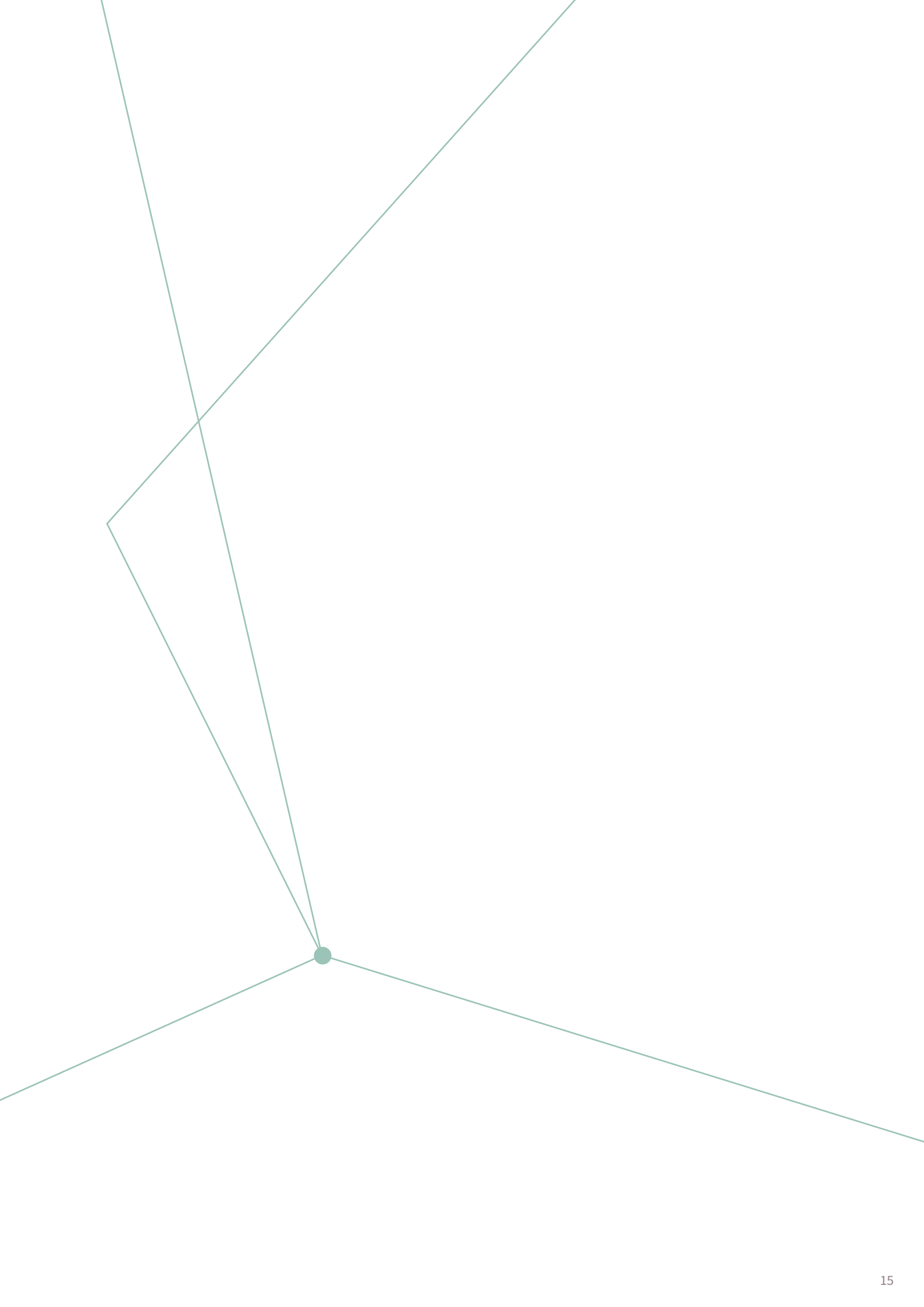
Conclusion

The move from traditional ID to eID has meant the integration of one or more card technologies in the production process.

Assuming contactless is the last step in the smart card evolution thanks to its convenience, flexibility in design of the card surface and with no wearing out of contacts, the logical next step for today's contact-based national ID cards would be to migrate to a dual interface format as a bridge between existing traditional infrastructures and future contactless systems.

With more applications being added to the functionality of an ID card, there is a greater urgency for industry innovation in addressing the physical durability issues that are required to future-proof the credential of tomorrow. Requirements for durability and flexibility in card design will increase as greater customization of the card takes place alongside increased usage of the cards and documents.

The benefits demonstrated by inductive coupling technology as well as Infineon's drive towards much leaner chip modules will go a long way to delivering both an advanced ruggedness of the card and enhanced tamper resistance. With these functionalities in place, the ten-year lifetime requirement of the card becomes a reality.



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