Product Marking with Codes: From Identification to Authentication

How Data Standards, Serialization and Authentication Correlate in the Coding of Products
Barcodes and 2D codes are used in just about any area of product marking. Now, individual marking of discrete product items is also playing an increasingly important role for industry and consumers. The keyword is serialization. It complements the conventional classification or type designation of a product, consisting of article number and further article information, by item-unique numbering. But beware of misconceptions: item-unique numbering does not ensure that the item in your hands is an original product. Only in combination with authenticity features can a system be comprehensively protected against fraud, misuse and counterfeiting.

This article describes the possibilities and limits of codes and their standards, as well as available options to protect item-unique markings from counterfeiting.

1. The Wide World of Codes

1.1 Introduction of the Various Code Types

Easy to create on practically any printing system, barcodes are used whenever products are to be marked in machine-readable form. Reading the information only requires optical line-of-sight to the marked object. This applies to any area in which the creation and application of variable data on short notice is desirable. The information can then be automatically acquired for a wide variety of uses. Today’s fields of application encompass order tracking in automated manufacturing operations, item marking, warehousing and logistics, materials tracking or machine control. Businesses and organizations use specific codes with consistent, standardized data structures.

Basically, code types can be differentiated as follows:

- **Linear codes** consist of a line with bars and spaces. The most commonly known and used barcodes are EAN/UPC (acc. to ISO/IEC 15420), Code 128 (ISO/IEC 15417) and Code 39 (ISO/IEC 1638). The specifications establish the exact requirements for syntax, bar and gap size (module width), and the quiet zones of the encoding area.

- **Stacked barcodes** are composed of a number of lines with bars and spaces.

- **Combined symbols** are made up of several components. The code is supplemented with a 2D component. Due to the supplementation of the code information with a second axis, data can be compressed, which allows more information to be captured in a very small space.

- **2D or matrix codes** always have an alphanumerical structure, consisting of polygonal, typically quadrangular, configurations of data cell groups. Additionally, they have an error-correction algorithm, which makes reliable reading possible even in the case of minor damage. The Datamatrix code in particular is very compact and secure. It allows a large number of diverse symbols and fonts to be used in the encryption.

1.2 Code Quality and Code Syntax

The quality of codes is decisively determined by the printing technique or print resolution and the printing substrates, with the relevant module size and contrast being the key factors.

The accuracy of the module dimensions, reflection values, adjacency contrast (the difference of bar and gap reflection), modulation, as well as the size and frequency of voids or other defects, are measured to determine and grade the code quality. Barcodes are graded based on the ANSI X3.192-1990 test standard or the worldwide ISO IEC 15416 standard. For grading 2D codes, ISO/IEC 15415 is the relevant standard.

Codes always offer a standardized syntax for optional data content. The Datamatrix code, for example, has a variable, rectangular size in the form of a matrix. The matrix consists of a square configuration of 10 x 10 up to a maximum of
144 x 144 symbolic elements. Up to 2,335 ASCII characters or 3,116 digits can be encoded.

Today, products are typically marked with an article/item, batch and/or serial number, a manufacturing or expiration date, as well as other product-specific information. Since recently, products have increasingly been serialized as well. In this case, all products of an order, batch or lot are no longer provided with the same code, but with a specific, item-unique marking using open or encoded numbering.

2. Opportunities and Limits of Serialization

Serialization by means of diverse barcodes or 2D codes offers opportunities and serves to perform a wide range of tasks, from controlling internal logistics processes, monitoring distribution chains, to offering product-specific value-added services. It ensures the correct usage of products, and all the relevant information such as serial numbers, service agreement details and maintenance history is summarized in a digital file. This increases the reliability and speed of handling orders and deliveries, as well as responding to service requirements. In addition, serialization offers brand owners opportunities for warranty extensions. However, a truly secure marking only exists if products, in addition to an identification marker, bear an authenticity feature as well. Serialization alone hardly offers any protection because it is easy to copy and counterfeit.

2.1 Modular Tracing Systems

More and more products and components are variably marked today in order to enable a wide range of users, such as customers or consumers, to identify and authenticate products and to access additional, item-specific information. Thanks to the widespread availability of barcode reader applications by smartphone apps, modular tracing systems offer easy and fast internet-based identification. For this purpose, every product is provided with a unique encrypted code. The product is authenticated by entering the code on the manufacturer’s website or using a smartphone. For mobile queries, the code is printed either
as a linear or a 2D code, or may even be stored on an NFC chip. By means of a freely available barcode app, users can read the code using the camera or an integrated NFC reader unit of their smartphone and start the fully automatic decryption process of the encoded information.

2.2 Safeguarding Variable Codes

The variable code information is now increasingly often combined with an anti-counterfeiting feature applied alongside the code. A “static” anti-counterfeiting feature like a hologram or a customer logo – printed with security ink – can be authenticated by optical comparison. Variable anti-counterfeiting features, such as a security paper with colored fibers, a printed random pattern, pixels or air bubbles cast in synthetic resin, reference each individual code via a database query. This query may be performed as a so-called “self-verifying” system via an encryption without an internet connection if the variable code references individual characteristics of the variable anti-counterfeiting feature. However, variable information is typically checked “online” via a database. This option offers greater freedom of design, as it allows users to query further item-specific information or write back into the database in the case of maintenance or repairs, for example. Particularly in consumer communications, this opens up diverse opportunities for brand owners to offer specific product information tailored to target groups, consumer tips or individual advertising via the smartphone-internet surface.

3. Authentication by Means of Security Features

Anti-counterfeiting features may be visible, hidden or digitalized, in other words “computer-readable,” depending on the target group that is intended to perform the authentication. All the features may be individualized and freely combined based on a modular concept. This results in highly complex security seals that successfully put a stop to the game of counterfeiters.

- **Overt features** such as holograms or security color-shifting inks enable fast authentication without the use of tools. Due to the risk of imitation by professional counterfeiters, a combination with additional covert and digital technologies is recommended.
Digital security features use computer-generated and highly encrypted encodings as human-readable numbers, 2D Datamatrix codes or special random patterns to enable authentication via the internet or mobile end devices. In many markets, the relevant marking ideally combines the machine readability of the code with a machine-readable authenticity feature. One of the available options to achieve this is the BitSecure copying protection technology. It is based on a digital random pattern and read by means of handheld scanners or the camera function of smartphones.

Covert features for authenticity protection are only made visible by tools such as special readers or test pens. In this case, technologies from high-security printing are primarily used. Available options include the incorporation of odorless and colorless taggants into the ink, integration of microscopically small micro-particles or a synthetically generated DNA code.

The optimum combination of identification and anti-counterfeiting technologies results in a meaningful symbiosis that equally benefits industrial users, service technicians, inspectors and consumers.

4. Examples from Various Markets

4.1 The MAPP Initiative in the Automotive Industry

Fake spare parts cause major damage in the automotive industry. CLEPA, the European Association of Automotive Suppliers, estimates that counterfeit automobile parts cost the supplier industry between five and ten billion euros per year. Aside from the loss of sales, this poses a major safety risk to motorists as well. Therefore, several CLEPA members launched an industry initiative billed as “Manufacturers against Product Piracy” (MAPP). Within this framework, they label their original products with a Datamatrix code based on an encoding recommendation developed by CLEPA. This unique MAPP code can very easily be authenticated using TecIdentify, the first IT-based standard solution for the automotive spare parts industry. Within seconds, the user knows whether or not the spare part is an original one. Bosch, Continental/ATE, Federal-Mogul Motorparts, GKN, Mahle, MANN-FILTER, MSI, Schaeffler, TRW, WABCO and TecAlliance-TecCom support the initiative that aims to increase awareness of the MAPP code.
4.2 The SecurPharm Initiative of the Pharmaceutical Industry

Counterfeit medicines are posing a growing risk to patient safety around the world. The European Federation of Pharmaceutical Industries and Associations (EFPIA) has therefore been advocating standardized serialization labeling of packaging at unit-of-sales level by means of Datamatrix codes for many years. EU Directive 2011/62/EU, the so-called Falsified Medicines Directive, also requires future EU-wide marking of all prescription drugs with a security feature for reliable identification. The recently published Delegated Acts now detail the specific serialization requirements to be implemented by the manufacturers during a three-year transition period. Every product has to be marked with a unique identifier (i.e. a serial number), a product code, the national approval number, as well as the batch number and expiration date. The SecurPharm initiative of the German pharmaceutical industry has been testing these requirements in a large-scale pilot project since 2013. The new system is designed to enable the identification of medicines at pharmacies in the future, with the pharmacist verifying the product at the time of dispensing it. Via the encoding, additional information such as item and batch numbers or the expiration date can be queried. A comparison of the product data on the packaging with a corresponding entry in the repository ensures that only approved products are dispensed – and issued only once. The system checks if the data record exists and matches the query, if additional information has been stored or if warnings, such as recalls of individual batches, have been issued.

4.3 Beef Labeling in the Food Industry

Since 2002, Germany has had a system in the Beef Labeling Act that governs the assurance of origin and the tracing of beef. It must be complied with in addition to the general regulations of food law and food labeling. The origin of beef is thus made transparent. The intent is to make beef traceable from the sales counter across all the marketing and production stages, all the way back to a group of animals. The mandatory information has to be provided by all market players on each level of the marketing chain. In addition to the approval numbers of slaughterhouses and cutting plants, information such as date of birth, country of
fattening and slaughtering, the mandatory data includes a reference number or reference code to assure the traceability of beef back to a single animal or group of animals. This is made possible by a national electronic database for the registration of cattle as part of the origin and information system HIT.

5. Going Forward

Legislators and industry associations support the trend of using serialized identification markers in the form of standardized codes. Standards, such as GS1, promote the use of common language and facilitate industry-wide communication and automation of processes. The current discussion of extending human-machine and machine-machine communication – billed as Industry 4.0 – accelerates the provision of corresponding systems and interfaces.

At the same time, increasing attention is being paid to the issue of security. Aside from the aspect of technical counterfeiting protection, assurance of data security will pose the next challenge. In the future, data will be made available to more and more users through cloud solutions. Furthermore, current media reports show with brutal honesty that hardly any encryption or firewall poses an insurmountable hurdle to hackers or intelligence agencies. This is why security management has to be understood in more comprehensive ways. In addition to data protection and data security aspects, all track-and-trace processes require careful planning: Who needs what information when? What information is confidential and what information is publicly accessible?

Identification and tracking systems are becoming increasingly powerful. However, only if aspects of security, availability and ease of use are taking into account can they deliver their full potential and contribute to success.

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