WHITE PAPER

HOW TO DEVELOP TRACEABILITY SOLUTIONS FOR INDUSTRY 4.0 USING SAFE MARKING AND IDENTIFICATION SYSTEMS.

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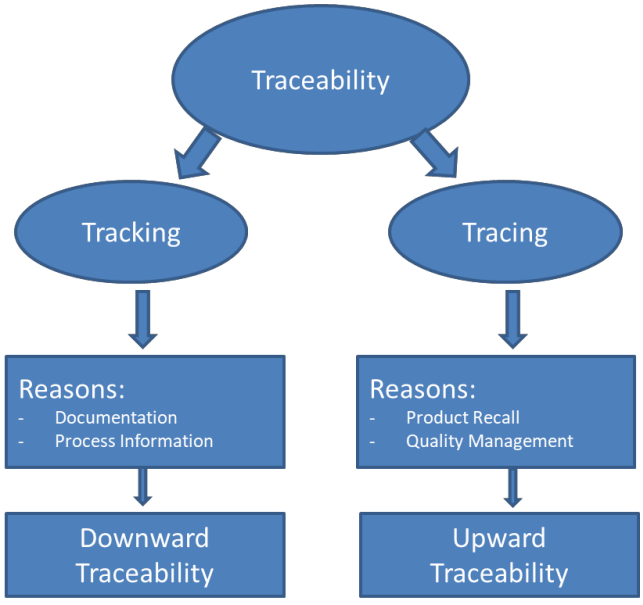
INTRODUCTION

With greater product liability, rising quality standards and more complex customer requirements, traceability is a subject that is increasingly important and developing into a fundamental prerequisite to be able to conduct business at all in future. Industry 4.0 technologies provide companies not just with the possibility of quickly and systematically determining errors, but actually avoiding errors during the manufacturing processes and thus improving quality. The basis for traceability is the marking and identification of products. Marking and data collection systems are an important component of this. These depend on safe solutions that ensure traceability across the entire product lifecycle. That is why this whitepaper focuses on laser marking as a permanent marking procedure and the safe visual identification and analysis of codes.

The term 'traceability' is included in quality standards across different sectors. In DIN EN ISO 9001, it says that organisations should identify their products and services uniquely using suitable means – to the extent that it is necessary to ensure their conformity – as well as store all information about the documented results in order to ensure traceability. Additionally, DIN EN ISO 9000 describes traceability as the ability to track the application or location of products, processes or systems. In this context, the traceability of hardware can refer to the origin of materials and parts, the operational sequence of the processing as well as the distribution and position of the product after delivery. Traceability therefore has two aspects: tracking and tracing



Traceability includes tracking and tracing

REASONS FOR TRACEABILITY

There are many reasons for companies to make seamless traceability necessary or useful. In more and more cases, traceability is an absolute must, since it is required by law, standards or supply chain agreements.

Quality standards

Traceability is an integral component of quality standards and guidelines. A multitude of associations have included traceability in their compliance requirements.

Product liability

"If material damage is incurred due to a fault in a product, then the manufacturer of the product is obligated to reimburse the damaged party for the resulting damage..."

Among other things, the Product Liability Act obligates the producer of vehicles and electrical appliances to document the manufacture and quality of products. Manufacturers and suppliers must be able to seamlessly prove the fault-free manufacture of all products and subcomponents as well as compliance with corresponding regulations in order not to be liable for any damages incurred. In medical technology, there are also strict legal regulations and conditions. The American regulation authority, the Food and Drug Administration (FDA), for example, requires detailed documentation of all production-relevant processes and specifications so that the product can be traced from the manufacturer to the customer in case of a recall.

Customer requirements

"The marking and traceability methods must be documented. The products must be clearly labelled during manufacture. It must be possible to trace batches down to the level of individual parts or raw materials..."

This formulation is not an excerpt from a quality standard, but a typical part of a framework purchasing contract. Traceability is included more and more frequently in the specifications for a collaboration. For example, manufacturers in the automotive industry have their own standards that must be met by suppliers. After all, traceability is the most important basis of modern automotive supplier processes, in which numerous safety-relevant components must be completely inspected and tracked to ensure fault-free processes along the entire supply chain.

Costs of recall actions

Recall actions can cause very high costs and damage a company's image in the long term. The risk of large-scale disasters can be reduced effectively through seamless traceability. In case of a recall, fast and targeted reactions are possible – down to the recall of just a single product. This makes it possible to reduce or avoid harm to a company's reputation and the risk of many dissatisfied customers.

Minimising errors, improving productivity

If errors occur during the production, traceability can be used to find the root causes in a structured and effective way, using reliable data. Seamless and fast error analysis leads to a minimisation of wasted materials and improves productivity.

Ensuring and improving quality

Through better and more detailed data collection and visibility, it is more likely that errors can be avoided. This is increasingly important, as the customer-specific required variation down to even a single batch is increasingly prevalent. A powerful traceability system can reliably ensure that no defective components are assembled or that any wrongly selected components are put to use in a customer device with different specifications.

Transparency and optimisation of processes

The gathering and analysis of production and process data at all production stages, results in higher process transparency and therefore creates the basis to continuously improve processes and handle them more efficiently.

What traceability can do:

- Meet legal requirements, standards and guidelines
- Limit product liability risks
- Meet increasing requirements of customers
- Avoid or limit recall actions
- Avoid reputation damage and improve customer satisfaction
- Prevent or reduce litigation
- Minimise waste and increase productivity
- Make processes transparent as the basis for continuous optimisation

HOW DOES TRACEABILITY WORK?

The core elements of a traceability system can be divided into three steps:

- Marking
- Identifying & analyzing
- Linking & communicating.

The specifications for traceability described in quality standards such as DIN EN ISO 9001 provide no information about how companies should set up their traceability system. This means that they are free to decide which solutions to use to meet their external and internal requirements. Traceability systems link the physical flow of goods with the corresponding information flow. The basis for this is the digitalisation and subsequent linking of data across the entire product and logistics chain through three core elements.

Marking

A functioning system for the traceability of products requires targeted identification with a unique marking – across the entire process. That is why raw materials and semi-finished goods need to be provided with markings, as do packaging and transport media. The objective of marking is company-wide tracking across the complete delivery and value-creation chain.

The marking of objects generally takes place with the help of visual codes or, in case of electronic identification, RFID tags (Radio Frequency Identification). When using visual markings, there are different procedures – from direct printing via labelling to embossing or laser marking. Permanent marking by laser has become a standard in many companies in the manufacturing industry.

Identifying & analysing

Once the products are uniquely marked with a code, this data must be gathered quickly and safely at important points of the manufacturing and logistics chain. Different versions and technologies are used, depending on the application area, type of marking or process conditions. For a visual identification, the spectrum ranges from laser scanners to cameras and from mobile devices to stationary identification systems. Since there are strict specifications for the quality of codes, it is important that the identification solutions can be analysed reliably, whether a code meets the requirements or not. This functionality is called code grading.

Linking & communicating

The devices and systems for automatic identification are connected to a database. This is where all gathered and recorded data is linked to make continuous and seamless traceability possible. Finally, there has to be a continuous and company-wide information flow between all partners within the traceability system to transmit all relevant data along the entire delivery and value-creation chain.

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SAFE MARKING AND IDENTIFICATION

How can objects be marked so safely that they are not just reliably traceable based on their code during the manufacturing process, but also after many years – even under the toughest operating conditions? Direct marking – Direct Part Marking (DPM) – offers the best and most robust solution to this question. With DPM, markings are applied directly to the surface of the object, for example through embossing, scoring or engraving. Marking with the help of laser technology is state-of-the-art today where the aim is to efficiently ensure safe and durable traceability. However there are also applications in which, for example, marking via direct printing or labelling ensures sufficiently safe traceability and thus represents a simpler or more economical solution. Also, direct marking may not be possible due to special material properties.

The interaction of visual labelling procedures and perfectly coordinated solutions for visual identification form the basis for maximum process reliability and seamless traceability.

LASER MARKING

A marking that lasts forever.

Due to its flexibility, versatility and process reliability, laser marking is one of the leading labelling procedures in the manufacturing industry.

The most important advantages of laser marking at a glance:

- Direct, permanent marking – inseparably tied to the object
- Permanently traceable even under the toughest conditions – resistant to abrasion, water, solvent, oil, temperature and UV
- Suitable for all kinds of surfaces – metals, plastics, ceramics, cardboard, wood, glass…
- Continuously high-contrast and legible
- High-precision – even for complex markings in small areas
- Flexible – the marking is individual and adjustable
- Hygienic – meets the highest cleanliness requirements
- Efficient and productive at high unit volume through automation
- No additional costs – no consumable materials or additional tools
- Environmentally friendly – without hazardous additives or waste
- Forgery-proof, since it cannot be removed

Laser marking systems are more expensive to acquire than conventional systems such as ink-jet, label or thermal transfer printing procedures. However, this investment is recouped in a short time due to the high production efficiency and with minimal costs for consumables and maintenance.

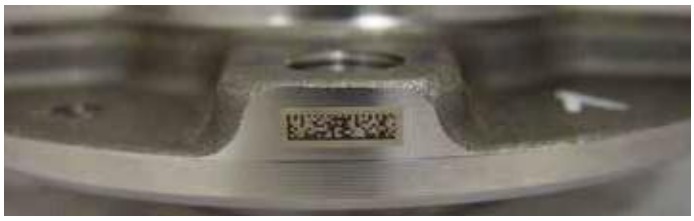
Laser marking is suitable for many different surfaces

Laser technology

When selecting a laser marking system, it should be noted that the right laser with the suitable wavelength must be selected for every material. There are different laser technologies – fibre laser, CO2 laser and DPSS laser (Diode Pumped Solid-State laser). A CO2 laser is suitable, for example, for the marking of wood, cardboard or glass, but not for metals. Fibre lasers and DPSS lasers can be used universally, but they reach their limits, for example, with glass. Generally, it's best to test a potential laser marking system in advance with the products that are to be marked. When it comes to plastics in particular, there are so many different compositions that a system may be suited for an application in principle, but may not lead to optimal results in practice.

All-in-one and individual solutions

Laser marking systems are available as all-in-one solutions or as individual solutions in which the marking head and the controller are separated. All-in-one solutions, due to their ultra-compact form factor, can be used in very confined spaces. Individual solutions, due to the spatial separation of the controller and the very small write head, make installation and system integration for all applications extremely simple. This makes it possible, for example, to place the marking head on a robot arm, allowing for a component to be marked automatically at several different positions on a single workstation.



An ultra-compact all-in-one fibre laser marker for a wide range of materials

A universal CO2 laser marker for paper, cardboard and organic materials

A DPSS laser (Diode Pumped Solid-State laser) for the marking of plastics and metal

Laser Marking Systems for different type of materials

		Co2-Laser EOX	YAG-/YVO4-Laser ULYXE/VLASE	Fibre-Laser UNIQ/AREX
Plastics	Polyethylene	++	++	++
	Polycarbonate	++	++	++
	Polypropylene	++	++	++
	Polyacetal	++	+++	+++
	Polybutylene terephthalate	++	+++	+++
	Polyethylene terephtalate	++	-	-
	Acrylic-Nitrilebutadien-Styrol	++	+++	+++
	Epoxide	+++	+++	+++
	Phenole	+++	+++	+++
	Urea	+++	+++	+++
	Polyvinyl Chloride	+++	+++	+++
	Polyamide	++	+++	+++
	Silicon	-	++	++
Metals	Iron/steel	-	+++	+++
	Aluminium	-	+++	+++
	Nickel	-	+++	+++
	Stainless Steel	-	+++	+++
	Copper	-	++	+
	Gold	-	++	+
Others	Ceramics	++	++	++
	Wood	+++	+	+
	Paper	+++	+	+
	Glass	+++	-	-
	Rubber	+++	+++	+++



OTHER MARKING PROCEDURES

Direct marking, direct printing or labelling – the execution and application of visual labels depends on, among other things, the type of product, the process flow, the process environment or the subsequent utilisation. The advantages of direct marking using laser technology – especially with regards to traceability – were already explained in section 2.1

Labelling

In the labelling process, usually a paper or plastic label is stuck to the product to be marked. Self-adhesive labelling is also suitable for many products and materials. If safe traceability is required however, there is a risk of intentional or unintentional removal of the label during the product lifecycle.

Direct printing

In direct printing, the visual marking is printed directly on the surface of the object. With this kind of marking, the only costs incurred are for the printer and ink. For direct printing, the structure and geometry of the surface must be printable in a process-reliable way with a suitable printing ink. The mechanical and chemical durability is not as high as with direct marking.

Digression on codes

Codes are the core of automatic identification. The most well-known code is the barcode, allowing printed data to be easily read by machine. However, the limitation of this 1D code lies in its maximum data volume. With 2D codes – for example, matrix codes – the encryption of several thousand characters can be realised in the smallest spaces. Thanks to error correction procedures, 2D codes can still be decrypted even when they are damaged or soiled.

SAFE IDENTIFICATION – DATA COLLECTION POSSIBLITIES

Technologies for automatic visual identification

The type of marking is one of the determining factors when selecting the most suitable technology for automatic visual identification. For example, laser scanners can read 1D codes at an extremely high scanning speed, but they are not suitable for 2D codes. 2D cameras can be used very flexibly and can read both 1D and 2D codes. In addition, plain text or characteristics such as shape, colour, dimensions or defects can also be recorded with camera-based image processing.

Hand-held devices and stationary systems

For identification tasks in production and logistics areas, both hand-held scanners and stationary systems are used. Hand-held devices are tied to a person and are generally used in partly-automated handling of goods and materials. In a fully automated material flow, stationary systems are the right choice. With these powerful solutions, fast moving objects can be identified with extremely high reliability in logistics and production processes.

The most suitable solutions for laser marking

Laser marking makes very different kinds of markings possible – from 1D codes via 2D codes to plain text. 2D cameras are suitable for the safe scanning of this data. That is why, in the interest of seamless traceability across all process steps and transfer points, two data acquisition systems will be used:

- Camera-based hand-held devices for partly-automated processes
- Fixed scanner with camera technology for fully automated processes

Note: Extensive information about the foundations of automatic identification and data acquisition possibilities can be found in the Datalogic whitepaper on "Automatic identification – Basis and driver for Industry 4.0"

Codes, characteristics and the appropriate registration

Features	Hand-Held-Scanner e.g.PowerScan, Gryphon	Unattended Scanning Systems (Laser) e.g. DS2100/2400, DS5100, DS8000	Unattended Scanning Systems (Camera) e.g. Matrix 120, 210N, 310N, 410N, 450N	Machine Vision Smart Cameras e.g. P-Series, T-Series
1D Barcodes	Yes	Yes	Yes	Yes
Automatic reading 1D Barcodes	No	Yes	Yes	Yes
2D Barcodes	Yes	No	Yes	Yes
Automatic reading 2D barcodes	No	No	Yes	Yes
Direct marked codes (DPM)	Yes	No	Yes	Yes
Automatic reading DPM codes	No	No	Yes	Yes
OCR Reading	Yes	No	No	Yes
Dimensioning of parts and error detection	No	No	No	Yes
Operator Software	Yes	Yes	Yes	Yes
Polarized models	No	No	Yes	Yes
Infrared models	No	No	Yes	Yes
Depth of field for reading codes in warehouses on pallets	Yes	Yes	No	No
USB-HID interface without software modification	Yes	No	Yes	No
Ethernet/Profinet interfaces	Yes	Yes	Yes	Yes

SAFE IDENTIFICATION – GRADING OF CODES

Whether you are dealing with 1D or 2D codes, labels or direct marking – when markings are being read, it must also be possible to analyse identification solutions reliably to find out whether a code is incomplete or faulty. In this case, traceability can no longer be guaranteed.

If a large batch of parts with faulty codes is installed or brought into circulation, this generally results in very high costs. Because of this, there are strict requirements regarding the quality of codes. When selecting a data collection system, care should be taken that it meets the relevant standards.

Standards for code grading

1D codes:		ISO/IEC 15416
2D codes:	Labels:	ISO/IEC 16022/18004 ISO/IEC 15415
	Direct-marked codes:	ISO/IEC 29158 (AIM-DPM)

This grading is possible both in the DL.CODE identification software as well as in the Marvis software (which combines the laser marker and scanner).

THE RIGHT SOLUTION FOR EVERY TASK

As an international market leader in automatic data capture and process automation, Datalogic offers the most extensive portfolio for automatic identification – from barcode scanning devices, mobile computers, sensors and image processing systems to laser markers.

In the area of visual marking and identification, the Datalogic portfolio ranges from safe direct marking with laser technologies to the reliable scanning and analysis of all kinds of codes and marking procedures. From laser to camera technology and from hand-held devices to stationary systems. The overall DL.CODE identification software meets all important standards for code grading.

Combining systems for marking and identification from a single source enables perfectly coordinated overall solutions for maximum process reliability and complete traceability

MARVIS: The complete solution for error-free laser marking

MARVIS™ connects the Datalogic products for laser marking and automatic identification in a uniform software environment with a single GUI (Graphical User Interface). Thanks to the integrated approach, the MARVIS solution automatically detects unusually high quantities of waste parts and applies corrective measures, including the possibility of marking the parts again. MARVIS™ uses innovative technologies for code grading and allows manufacturers to achieve zero-error marking and 100% legibility of the codes.

Additional information about safe marking and identification can be found at www.datalogic.com

Would you like to find out more, or do you have any special questions about specific applications or products? Speak to our Datalogic experts on 01582 790020 or send us an e-mail at marketing.uk@datalogic.com and a contact person from the relevant department will get back to you as soon as possible. We are happy to answer your questions.

Datalogic Group

Datalogic is a global leader in the automatic data capture and process automation markets, specializing in the design and production of bar code readers, mobile computers, sensors for detection, measurement and safety, RFID vision, and laser marking systems. Datalogic solutions help increase the efficiency and quality of processes in the retail, manufacturing, transportation and logistics, and healthcare industries along the entire value chain.

The world's leading players in these industries use Datalogic products, certain of the attention to the customer and of the quality of the products that the Group has been offering for 47 years. Today Datalogic Group, headquartered in Bologna (Italy), employs approximately 3,200 staff worldwide, distributed in 28 countries, with manufacturing and repair facilities in the U.S.A, Brazil, Italy, Slovakia, Hungary, Vietnam, China, and Australia. In 2018, Datalogic had a turnover of 631 million Euros and invested over 61,9 million Euros in research and development, with an asset of more than 1,200 patents in multiple jurisdictions.

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