INTRODUCTION TO INDUSTRIAL BARCODE READING

Understanding 1-D and 2-D code architectures and application methods makes choosing the ideal barcode reader a simple, black-and-white decision.

HTE AUTOMATION
a division of HTE Technologies

TABLE OF CONTENTS

What is a barcode **3**

How barcodes are used **5**

Types of barcodes **6**

1-D barcodes 6

2-D matrix codes 8

Barcode printing and marking methods **10**

Thermal transfer and inkjet printing 10

Direct park marking 11

Types of barcode readers **12**

Laser scanners 12

Vision-enabled readers 14

How to select a reader **19**

Glossary **25**

WHAT IS A BARCODE

A *barcode* is a machine-readable pattern applied to products, packages, or parts. Barcodes contain data used for informational and marketing purposes as well as for tracking products throughout their lifecycle.

Although barcode technology was originally patented in 1952, it wasn't until 1974 that the first product – a package of Wrigley's gum – was scanned at a Marsh® supermarket in Ohio. Today, barcodes come in dozens of different formats, from a row of simple lines called a *1-D (one-dimensional) barcode* to dots and squares that form a *2-D (two-dimensional) code*; *QR (Quick Response)* and *DataMatrix* codes are among the most popular 2-D codes. The more advanced 2-D code allows users to store and retrieve significantly more data than they could with a 1-D code. This is because 1-D codes only contain data in the horizontal direction whereas 2-D codes contain information both vertically and horizontally.

0123 4565

1-D linear barcode

DataMatrix code

QR code

Postal Code

Stacked linear barcode

Figure 1: 1-D and 2-D code formats

Traditionally, 1-D barcodes have been "read" by *laser scanners*. With this technology, a laser beam hits a rotating prism that directs the beam onto the barcode, where a sensor is used to capture the light intensity that is reflected back, distinguishing between black and white bars. Unfortunately, this scanning method has several limitations. For example, laser scanners cannot read 2-D codes, which are increasingly used in consumer and industrial applications ranging from aerospace and automotive to food and pharmaceuticals. Laser scanners also use mechanical rotating or oscillating mirrors or prisms that wear out and can easily be damaged from shock or vibration.

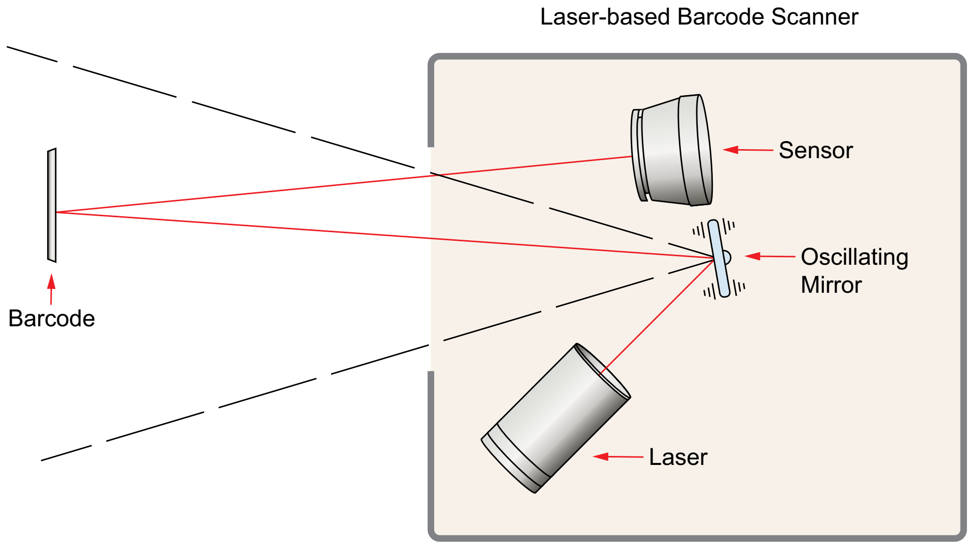

Figure 2: Laser-based barcode scanner

Alternatively, *vision-enabled barcode readers* have no moving parts and therefore are far more robust for industrial applications. Vision-enabled readers can also read 1-D and 2-D barcodes at any orientation. Single-line laser scanners, on the other hand, are not omnidirectional; the barcode must be oriented in front of the laser scanner.

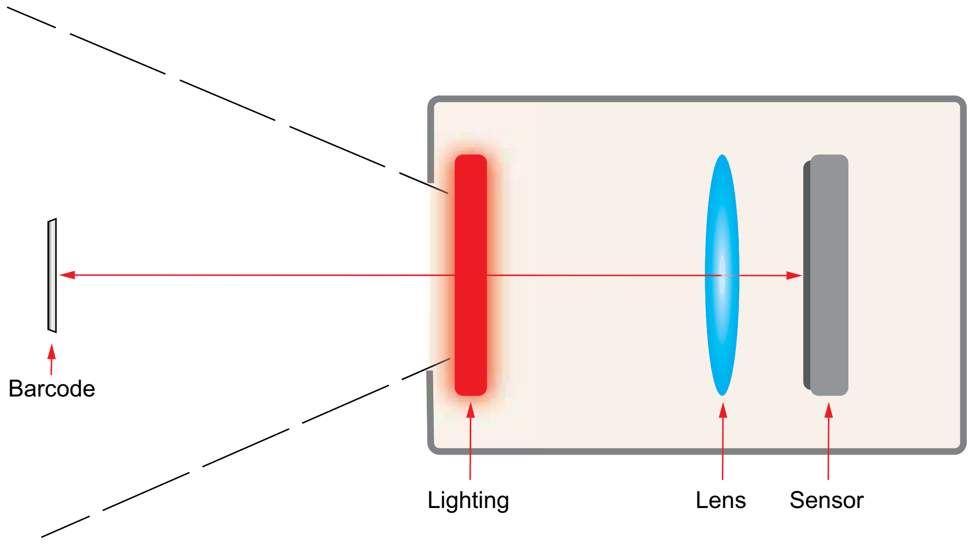

Figure 3: Vision-enabled barcode reader

HOW BARCODES ARE USED

Barcodes of one type or another can be found in most industries. For example, barcode applications have transformed the manufacturing, processing, and tracking fields in the food and beverage, packaging, retail distribution, medical, pharmaceutical, electronics, automotive and aerospace industries. Barcodes are found in every electronic and consumer product, from your cell phone battery to the box holding your new running shoes. The use of 1-D or 2-D codes reduces overhead costs by automating and simplifying supply chain management, inventory, check-out and purchasing.

Figure 4: Barcodes are used in almost every industry

Safety and liability are also drivers behind industry adoption of barcodes. In recent years, governments around the world have started to require medical devices and pharmaceutical manufacturers to apply machine-readable codes on every package down to individual medicine containers. Should a defective product reach a store shelf, automated tracking of every package will accelerate safety recalls while making quality-control data available to the entire supply chain.

TYPES OF BARCODES

1-D barcodes

The first barcodes implemented worldwide were 1-D barcodes. These linear codes only contain alphanumeric data. Each character in the code represents something different about the product and a database provides information on what each character means.

In most cases, 1-D barcodes are read from left to right. The widths of the spaces and bars relate to a specific character in the barcode. A *quiet zone* or *margin* is the white space to the left and the right of the barcode; this helps the reader to locate the barcode. As a general rule, the margins should be at least seven to ten times the narrowest bar width in the barcode.

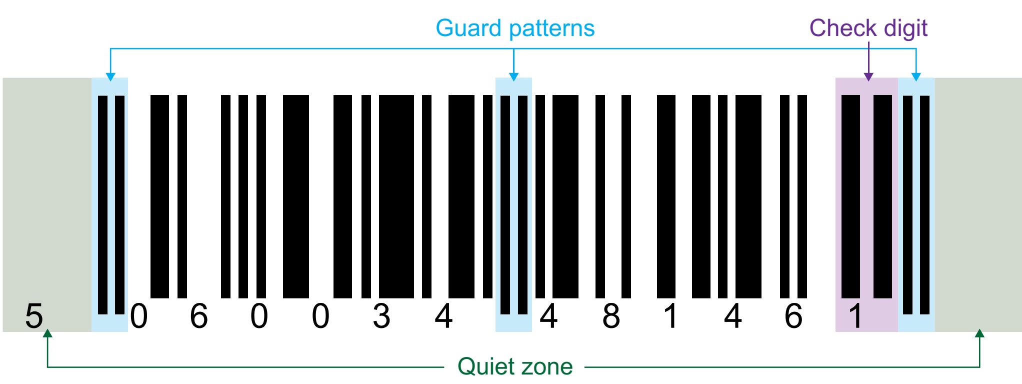

Figure 5: Structure of a 1-D code

All the other bars in the code are based off a ratio of the narrow bar width. For example, 2:1, 3:1 and 2.5:1 are common ratios that describe the width of white spaces and black bars based on the starting point of the narrowest black bar. Some barcodes also have a *guard pattern*. The guard pattern is at the beginning and end of the barcode; this pattern tells the reader where the barcode starts and ends.

Symbologies

Common 1-D barcodes include but are not limited to: the *GS1*; *UPC* (Universal Product Code), which is common in retail and consumer goods; *EAN* in the European Union; and Code *128*, which can describe any ASCII 128 character and is commonly used in logistics. Most of these barcodes include a check digit as part of its standard. The check digit is used to verify that the code is complete and not damaged or otherwise missing information; it does this by performing a mathematical operation on the data within the code.

Other 1-D codes, such as *Code 39* (widely used by the military), *POSTNET* (used by the United States Postal Service®), *Codabar*, and *Interleaved 2 of 5* offer optional *check digits*. If there will naturally be an increase in misreads. *Pharmacode*, which is used for the pharmaceutical industry, can be read both forward and backward. The drawback of this code is that it must be positioned the same way each time it is read, even with using an vision-enabled reader.

Code 128

ABC-1234

Typical usage:
Logistics

UPC-A

0 12345 67890 1

Typical usage:
Retail & Supermarkets in United States

EAN-13

0 123456 789012

Typical usage:
Retail & Supermarkets in Europe

Code 39

ABC-1234

Typical usage:
Military & Automotive

Code 93

ABC-1234-DEF

Typical usage:
Military, Automotive & Healthcare

Codabar

A123456789B

Typical usage:
U.S. Blood Banks, Photo Labs, FedEx® Airbills and Libraries

Interleaved 2 of 5

0123456789

Typical usage:
Distribution & Warehousing

MSI/Plessy

0123456789

Typical usage:
Supermarkets

POSTNET

Typical usage:
United States Postal Service (USPS®)

Intelligent Mail Barcode

Typical usage:
Some United States Postal Service (USPS)

Figure 6: Types of 1-D codes

2-D matrix codes

Unlike 1-D barcodes, 2-D matrix codes contain information both horizontally and vertically, allowing them to store much more data. For example, a single 2-D code can hold up to 3,116 numeric characters or 2,335 alphanumeric characters, compared to the 39 characters that Code 39 can hold.

Unlike 1-D barcodes, all 2-D codes have built-in error correction, similar to the check digits in some 1-D codes, which effectively eliminates misreads. Within a single 2-D DataMatrix code, the data is typically encoded three times, which significantly increases the chances the code will be read correctly. Vision-enabled barcode readers would have to scan 10.5 million codes to misread a single 2-D barcode; laser scanners, which cannot read 2-D codes, cannot claim this level of accuracy.

While 1-D codes have quiet zones and guard patterns to identify where the code starts and stops, a 2-D code has a quiet zone, *a finder pattern*, and *a clocking pattern*. The finder pattern is the L-shaped pattern located around the outside edge of two sides of the 2-D code. This is used to ensure proper orientation during decoding. Opposite the finder pattern is the clocking pattern, a series of alternating black and white modules (or cells) that defines how big a single cell is and the size of the code (number of rows and columns) for decoding. The quiet zone is similar to that of 1-D barcodes; for 2-D codes, however, it must surround the entire code.

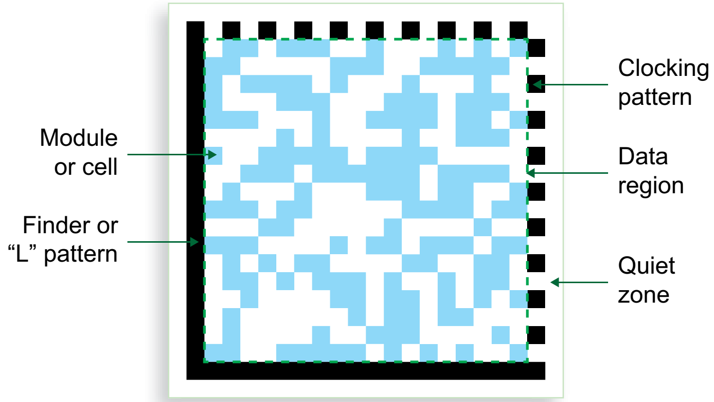

Figure 7: Structure of a 2-D code

Symbologies

Common 2-D codes include: DataMatrix, utilized by aerospace, defense, printed media and the U.S. Postal Service; *MaxiCode*, a dot-based code that is used in logistics applications; QR codes, used in automotive and commercial marketing applications; and *Aztec* codes, used by ticket agencies and rental car companies.

DataMatrix

Typical Usage:
Aerospace,
Automotive,
Electronics,
United States Postal Service (USPS)

MaxiCode

Typical Usage:
Logistics

QR

Typical Usage:
Automotive Parts & Commercial Marketing

Aztec

Typical Usage:
Travel Tickets & Car Registration Documents

PDF417

Typical Usage:
U.S. Driver's Licenses & Logistics

GS1 DataBar Stacked

Typical Usage:
Supermarkets

DotCode

Typical Usage:
Packaging, Logistics & Anti-theft Initiatives

Figure 8: Types of 2-D codes

BARCODE PRINTING AND MARKING METHODS

Every code application begins with collecting information from a central database, which often includes the origin and other manufacturing data, and then applying that data to an object. The application of the code is usually accomplished in one of two ways: by applying the code to a package or label, usually using inkjet or thermal printing methods, or by permanently marking the code directly on a part via *direct part marking (DPM)* methods such as *dot peen*, *chemical etching*, or *laser marking*.

Thermal transfer or inkjet printing

Inkjet printers are most commonly used for printing the code on a package, label or other material. Inkjet printers create the barcode by propelling droplets of ink onto a substrate such as paper or plastic. Thermal transfer technology is typically used for printing labels. This process heats up the print head and applies ink directly to the label. Inkjet and thermal printing are often used to print 1-D barcodes.

Figure 9: Inkjet-printed code on pharmaceutical bottles

Direct part marking

For many applications, such as medical devices, automotive parts and other durable goods where traceability and liability protection at the component level are important, DPM methods offer a longer-lasting alternative compared to printing methods. DPM solutions will typically include more data than just a part index number; therefore, they often use 2-D codes instead of lower-bandwidth 1-D barcodes.

Laser

Laser marking systems typically use fiber lasers to engrave DataMatrix codes or other 2-D code symbologies on the part.

Figure 10: Laser-marked code on a metal cylinder

Dot peen

Dot peen marking systems, generally considered the most cost-effective option, use an oscillating stylus to press into the metal, creating a divot.

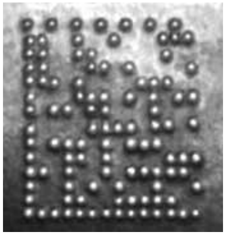

Figure 11: Dot peen-marked code on an automotive part

Chemical etching

Electrical chemical etching uses a sodium-based solution combined with a pulsing low-voltage electrical current. The charged solution dissolves the metal, which is then extracted through a special stencil.

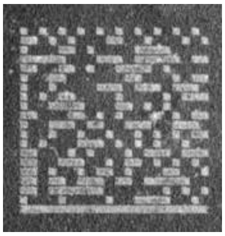

Figure 12: Chemically-etched code on metal

Depending on the material being marked, each method has its own strengths and weaknesses. For metal parts, laser-marking systems offer high-throughput permanent marks but are costly to install. Dot peen marking heads are less expensive but they wear down, which can compromise the mark. Interestingly, some vision-enabled code reading systems can monitor the quality of printers and DPMs, alerting machine operators to clogged print or worn marking heads.

TYPES OF BARCODE READERS

Laser scanners

In the early days of barcodes, codes could only be read by lasers. Laser scanners use a laser beam as a light source and typically employ oscillating mirrors or rotating prisms to scan the laser beam back and forth across the barcode. A photodiode then measures the reflected light from the barcode. An analog signal is created from the photodiode, and is then converted into a digital signal.

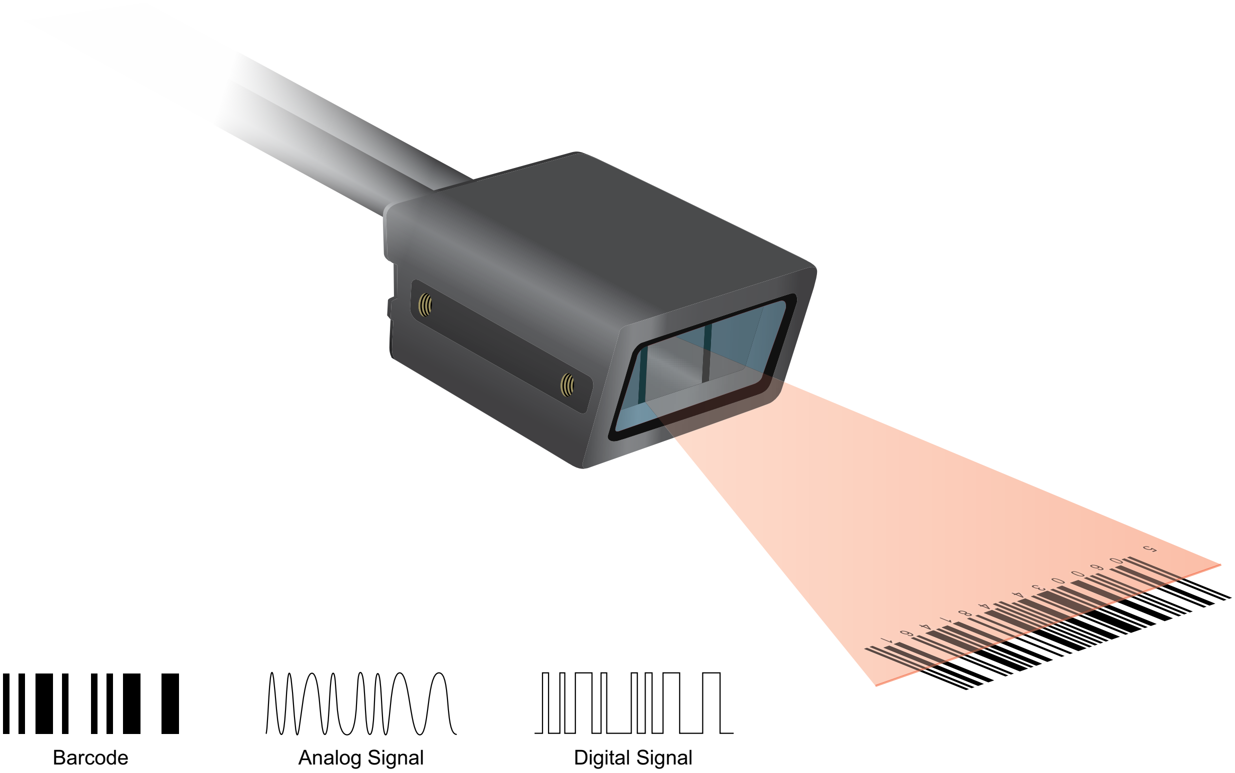

Figure 13: Laser scanners

Despite being an older technology, laser scanners still offer some operational benefits. Laser scanners do not require an image processor. They are also fast, capable of conducting up to 1,300 scans per second. Finally, because they use lasers – collimated beams of light that essentially do not diverge no matter how far the light travels from the source – they can read 1-D barcodes from relatively long distances with the use of special optics.

This does not mean that laser scanners do not have limitations. Among their crucial limitations is that they cannot read 2-D codes, which are becoming increasingly more prevalent than 1-D codes. Laser scanners also can have trouble with 1-D barcodes that are poorly printed, low-contrast, distorted, or damaged. Because the environment for code reading is rarely perfect, the number of misreads and no-reads are typically too high. The combination of highly reflective parts and light sources often create *hotspots* that confound laser scanners.

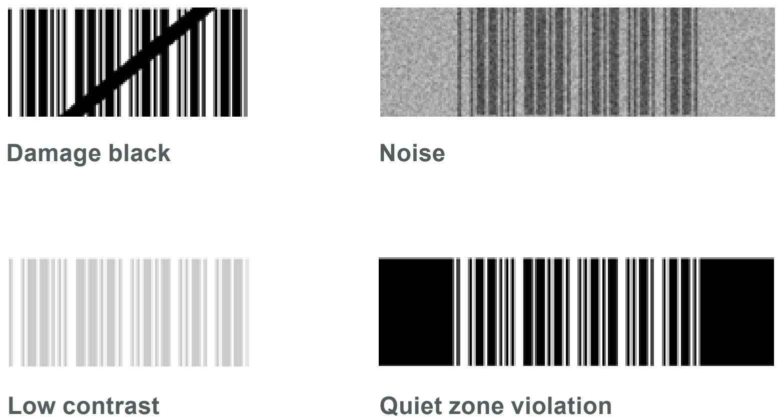

Figure 14: Codes that can be hard to read with a laser scanner

Code position is also critical to laser scanners because, with few exceptions, 1-D codes must be scanned from left to right. This can require additional fixturing or mechanical systems to make sure an object's barcode is consistently oriented in a single direction. Laser scanners also have an oscillating mirror, and moving parts can break, resulting in additional costs and time required to repair or replace. Finally, due to eye safety concerns, laser scanners must be shielded to protect nearby workers.

Vision-enabled readers

Vision-enabled readers essentially consist of a digital camera that acquires a picture of the code. Then a microprocessor, running special image-processing software, locates and decodes the code before distributing the resulting data across a network.

Image resolution

One of the biggest differentiators for choosing an image sensor, or camera, is resolution. Image resolution refers to how many individual pixels make up each image.

When it comes to matching a vision-enabled reader's resolution to an application, one of the most common criteria is *pixels per module (PPM)*. PPM refers to how many pixels it will take to cover one cell or module of the code, and will confirm whether the camera has enough resolution to read the code. PPM is calculated by dividing the camera' s resolution in one direction (for example, 752 pixels for a standard resolution reader) by the Y-field of view in millimeters (78 mm), and then dividing the code size in millimeters by the modules (12 mm/22 modules). Finally, multiply these numbers together (5.26 PPM). It may sound complicated, but a configurator app or image-processing software running on industrial vision-enabled code readers can quickly calculate PPM. While the industry standard is a minimum of 1.5 to 2 PMM, Cognex's latest Hotbars II™ algorithm lowers that requirement to just 0.8 PPM.

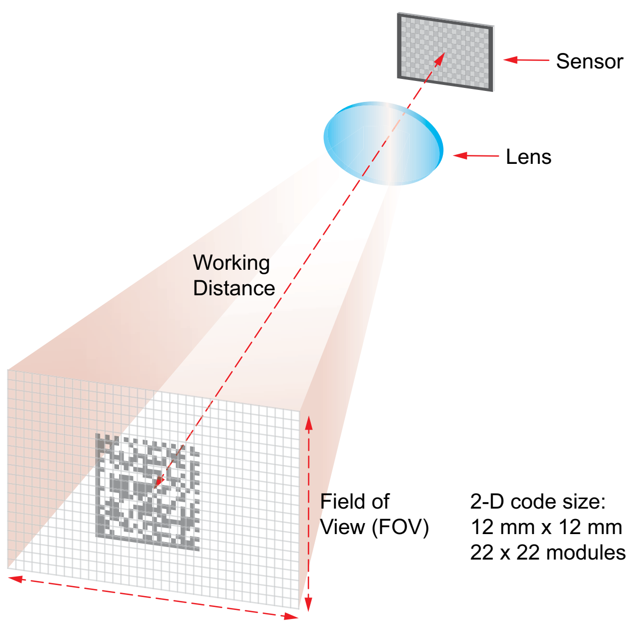

Figure 15: Pixel grid showing PPM on a DataMatrix code using an vision-enabled reader

Lenses

An vision-enabled barcode reader's optics are key for acquiring a good image of the code. Quality vision-enabled readers offer both *S- and C-mount lens* options, depending on the amount of resolution required at a given working distance to acquire an image of the code. The latest vision-enabled readers from Cognex also offer *liquid lens technology*, which allows the reader to adapt to changes in working distances between a fixed-mount reader and a product on a conveyor, for example. Liquid lenses use electrical charges to change the shape of the interface between two different liquids, oil and water. This bends the light and brings the image into focus. Unlike traditional zoom lenses, liquid lenses do not move or use motors and therefore are much more robust than mechanical or spinning optics.

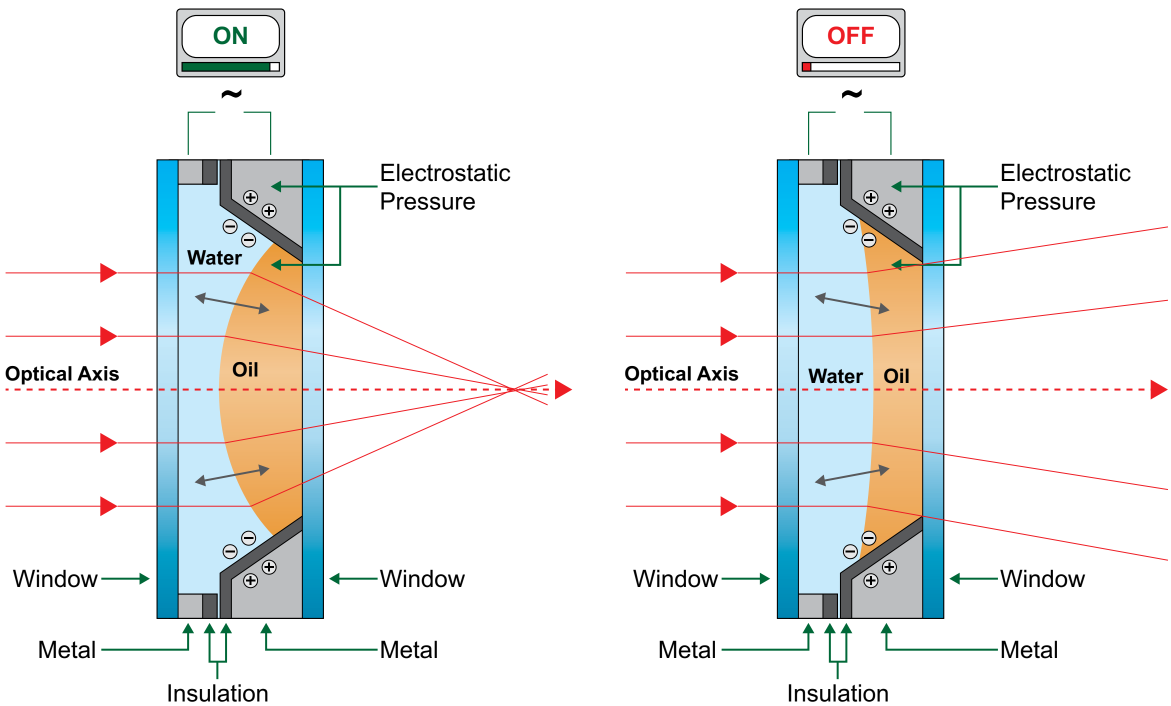

Figure 16: Liquid lens technology

Lighting

Lighting also has an important part to play in acquiring a good code image. Industrial vision-enabled readers typically come with lighting options to accurately read any code from printed labels to recessed dot peen codes. Cognex vision-enabled handheld readers offer all three types of primary lighting: bright field, dark field, and diffuse dome lighting. Bright field highlights the marks that make up the code, while dark field refers to low-angle light that highlights the areas around the code marking, and is best for reading dot peen and recessed codes. Diffuse dome light is best used on reflective and curved parts, as it reduces hotspots and generates a high-contrast image. Cognex fixed-mount readers offer integrated lighting options as well as external lighting options. There are many other lighting options available. Consult Cognex Lighting Advisor (www.cognex.com/lightingadvisor) to explore the effects of different lighting techniques and positions.

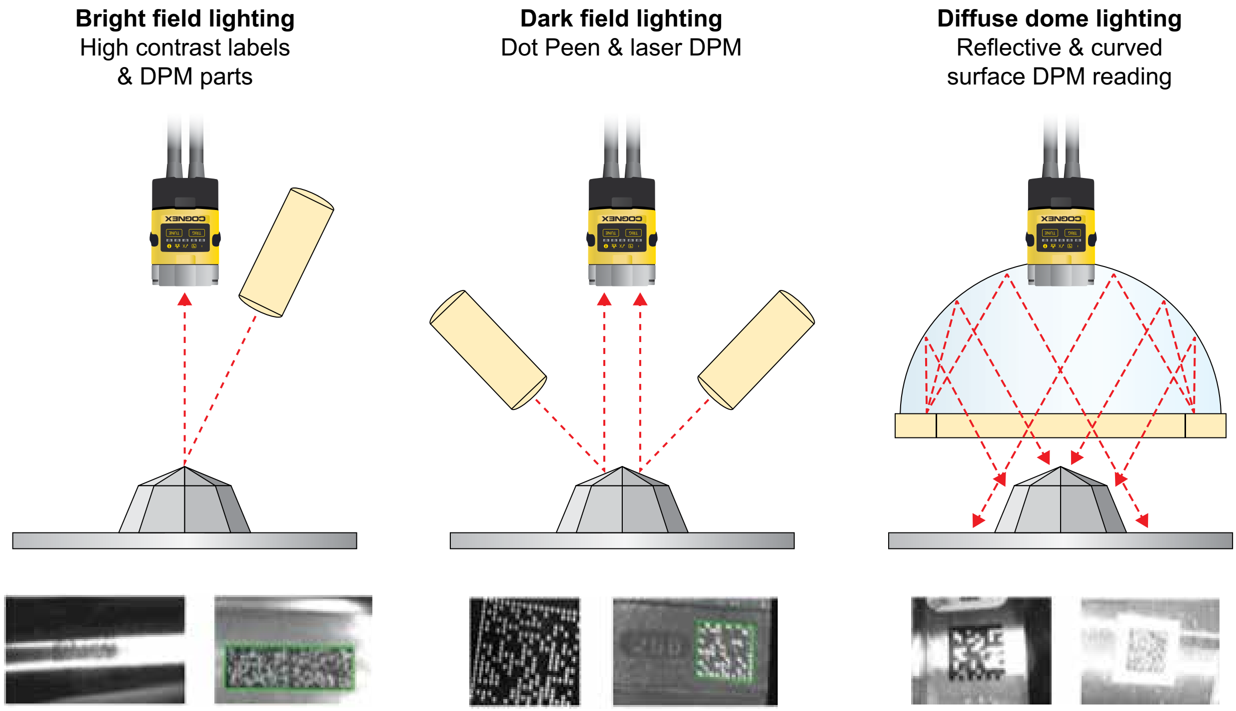

Figure 17: Lighting technology

Liquid lens technology helps barcode read rate increase from 75% to 100%

Challenge

Achieve a 100% read rate of barcodes on different sizes of shrink-wrapped fiberglass rolls as they were stacked onto skids.

Solution

Owens Corning® deployed the DataMan® barcode reader with liquid lens technology to automatically adjust the reader's focus to varying focal lengths.

The ability to fine-tune the set-up and adjust the contrast and brightness overcame the specular glare caused by transparent shrink-wrap material.

A near-100% read rate eliminated the need for the operator to manually intervene in the automatic sequence and ensure that the label was on the top of the roll. This freed operators to perform other tasks in the production process.

DataMan barcode readers help battery manufacturer solve read-rate and interface challenges

Application

Improve read rates on 2-D DataMatrix codes burned into plastic with a laser marker and also create a more seamless interface between code readers and the programmable logic controllers (PLCs) used to control production lines.

Solution

Deployed DataMan readers with industrial protocols and 2-D decoding software which can handle a wide range of degradations to the appearance of code.

Higher read rates have virtually eliminated the need for manual barcode data entry during the production process. The company has experienced a significant reduction in throughput and concern about data entry errors.

Communications

Finally, best-in-class vision-enabled readers offer a full range of industrial communication protocols including *Ethernet*, *USB*, *RS-232, discrete I/O, Ethernet/IP, PROFINET* and *Modbus TCP/IP*. This simplifies integration between reader and plant network, which is critical not only for reading and sending product tracking information, but also for storing archived images in the event of a rare no-read or misread. Best-in-class vision-enabled readers allow the failed image to be analyzed and stored for later review, and for alerts to be issued to operations staff that a code printer isn't printing with sufficient contrast, or that a dot peen head needs to be replace, for example. This ability to evaluate performance in real time and provide *statistical process control (SPC)* is another benefit of image readers over their laser scanner predecessors.

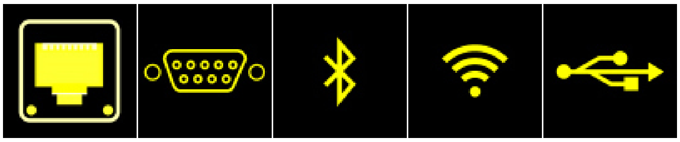

Figure 18: Communication protocols

With the additional power and flexibility of vision-enabled readers, industrial customers might expect vision-enabled readers to cost considerably more than laser scanners. While that was true in the past, the latest vision-enabled readers cost about the same as industrial laser scanners that have far less functionality. New *microprocessors* and *CMOS digital sensor chips* also mean vision-enabled systems can be nearly as fast as the fastest laser scanner. And these developments come in addition to the traditional benefits of vision-enabled readers: no moving parts, resulting in a longer life than lasers; ability to read damaged and omnidirectional codes; and ability to store images for audits and tracking and to monitor code marking systems.

HOW TO SELECT A READER

Selecting the perfect barcode reader starts with a careful examination of your code-reading application. What types of codes are you reading, how fast is the line, and how durable do you want the solution? Where will the reader be located, and with what physical restrictions? How will the reader communicate? But that’s not all you need to consider.

Symbologies

Data requirements for your inventory or track and trace application may be only a few kilobytes today, which may make a 1-D barcode seem the most logical choice. But data requirements are likely to grow along with the size and complexity of your operation. It is worthwhile to anticipate future requirements that would benefit from a 2-D code or the ability to read compromised barcodes. You may own your distribution channels today, but growth or new clients in remote locations may necessitate a third-party logistics company, leaving you no longer in control of the code-marking quality. Investing in better technology today may minimize future equipment upgrades.

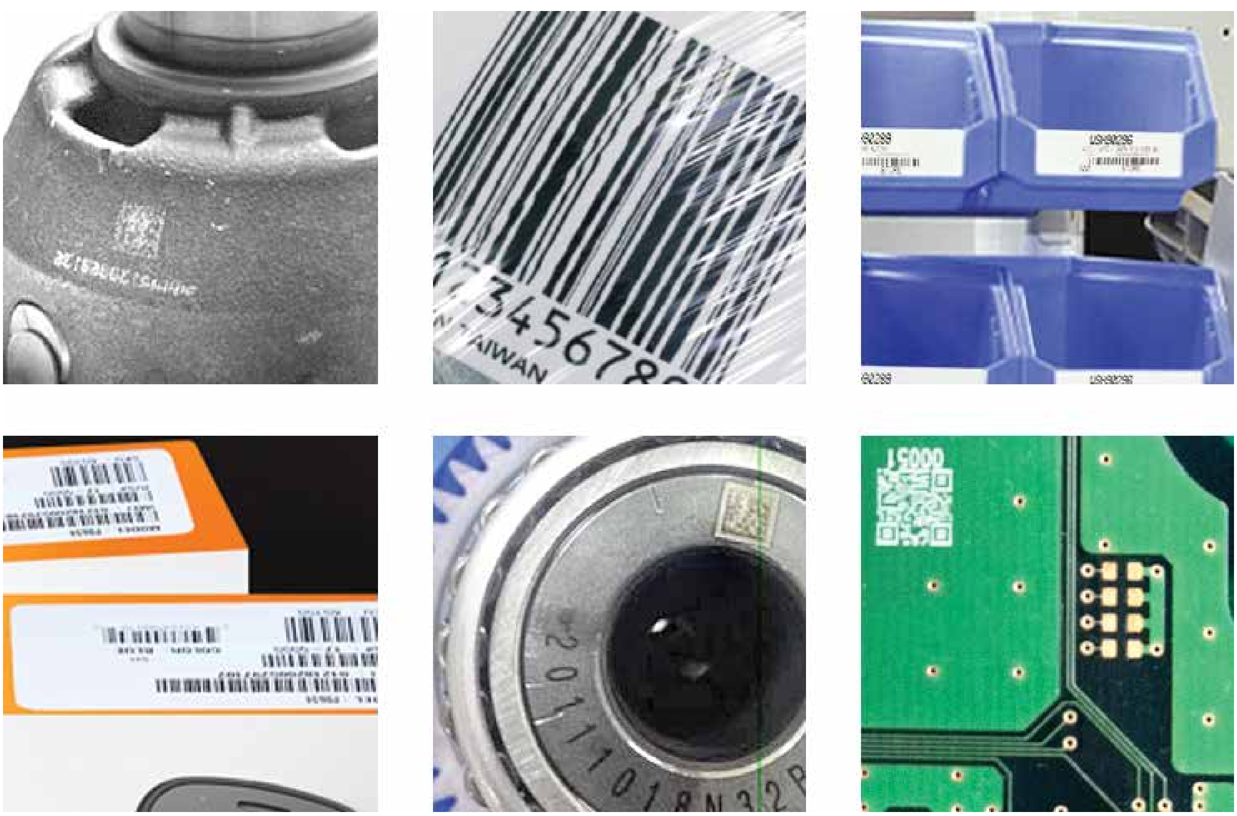

Figure 19: Barcode symbologies

Read rates

Every time a machine or person handles your products there is a chance that the machine-readable code could be damaged. So even if a product's data requirements, shape, and size point to a 1-D barcode solution, without the built-in error correction of a 2-D code, your supply chain is at risk from every rough conveyor wheel, sharp metal fixture, or dirty glove – anything that could smudge, scratch or compromise a machine-readable code. Without error correction, bad codes mean low read rates, more rework, and higher labor costs.

This problem isn't limited to paper and plastic packages. Even codes etched into metal can be distorted or damaged. So if supply chain accuracy is important to your business, make sure your reader can read noisy codes – such as those that are printed on cardboard or are scratched, deformed or low contrast – not just perfect codes fresh off the printer. And when printers, imprinters, or lasers go out of specification (and they will) feel secure knowing your vision-enabled system will alert you before thousands of defective products go out the door.

Figure 20: Vision-enabled barcode readers reliably read even the most challenging codes

Usage

The scanning environment will also indicate which type of reader you need. If your application calls for reading cartons of various sizes traveling at high speed down a conveyor, then a small fixed reader will be the best choice. If the reader is the final inventory check for dock workers loading incoming materials or outgoing product, a handheld code reader will be ideal. If it's a courier or technician working in the field, a mobile computer with built-in code reading capability will help quickly scan packages or check equipment specifications.

Figure 21: Types of vision-enabled barcode readers

Total cost of ownership

In order to quantify the cost impact of read rates, it's first important to understand what happens when a barcode scanner cannot read a barcode. When a ”no-read” condition occurs, packages must be diverted to a station where an operator can manually key in the information or replace the defective barcode and resend the package back through the sorting system. This type of failed condition results in increased labor costs and reduced efficiency of automated sorting equipment

To put the effects of failed reads into context, consider a high-volume distribution center that processes more than 125,000 packages per day. If that facility improves read rates from 99% to 99.9% by adopting image based code readers, management can expect to avoid more than 1,100 failed reads per day, saving nearly $150,000 in labor costs each year, based on an average time to rework no-read packages of 1.5 minutes and hourly labor costs of $15/hour. And these are just the financial costs, also worth of consideration are the soft costs, such as damage to client relations or corporate brands. (See Tables)

Table 1: Analyzing total cost of ownership—high-volume distribution center assumptions

High-volume shipping sorter typical of a large retailer	
Sorter speed, feet/minute	400
Average box size, inches	20
Distance between boxes, inches	30
Hours of operation/day	22
Utilization days/year	350
Boxes/second	1.6
Boxes/hour	5,760
Maximum boxes/day	126,720
Maximum boxes/year	44,352,000

Table 2: Analyzing total cost of ownership—high-volume distribution center read rate/labor cost analysis

High-Volume Read Rate/Labor Cost Analysis					
Read rate	No-reads	Maximum number of packages/day	Total rework time (man hours/day)	Number of operators required to handle rework	Cost of operators (USD/year)
97%	3,802	122,918	95.05	11.9	$499,012.50
98%	2,535	124,185	63.38	7.9	$332,718.75
99%	1,268	125,452	31.7	4	$166,425.00
99.50%	634	126,086	15.85	2	$83,212.50
99.90%	127	126,593	3.18	0.4	$16,668.75
Four Sigma	89	126,631	2.23	0.3	$11,681.25
Five Sigma	26	126,694	0.65	0.1	$3,412.50
Six Sigma	1	126,719	0.03	0.00	$131.25

With so much on the line when it comes to automated sorting systems, remember that when durability is factored in, operational costs far outweigh acquisition costs. So choosing a consumer-grade solution for an industrial application can only end in disappointment. Look for solid solutions that minimize failure points by design.

Vision-enabled readers help reduce drug counterfeits

Challenge

According to the EU Commission, the rate of counterfeit drugs has risen by around 400% since 2005. According to World Health Organization (WHO) estimates, it is assumed that around 10% of all medicines worldwide are counterfeits. In developing countries, that proportion even rises to 30%. It is therefore more important than ever in the fight against drug counterfeiters to have a clear identification and traceability of the original products.

Solution

A. Nattermann & Cie.® combined a direct part-marking system from Krempien+Petersen Qualitäts-Kontrollsysteme GmbH with a Cognex In-Sight vision system and DataMan barcode reader.

The DataMan reader verifies that the label is applied, while the In-Sight performs quality testing at the next station. The required 200-250 packages per minute were exceeded by almost 100%. With cycle times of up to 400 identified and controlled drug packages, a more than veritable result is guaranteed. During initial testing, only 40 pieces out of 250,000 during the two-shift operation were scrapped each day, a successful number for any operation.

DataMan accurately reads 2-D codes on a high-speed folding machine

Challenge

B3Servis is a folding machine builder that serves multiple industries in the Slovenian market, including pharmaceutical instruction leaflets that accompany. These leaflets need to be checked on both sides to ensure correct print and handling. This validation is done by matching the 2-D code on both sides of the leaflet with a reference code. To comply with the latest GS1 recommendations for the healthcare sector, B3Servis' business goal was to upgrade from the existing laser-based system that could only read 1-D codes to an image-based system, giving the company the ability to reliably check 2-D codes on a high-speed folding machine operating at speeds up to 30,000 pieces per hour, with a flyby speed of approximately three meters per second.

Solution

Instruction leaflets, handled by B3Servis, also come in different sizes and the codes will be positioned differently depending on the size, so the new reader needed to support multiple configurations of the leaflets. By moving to fixed-mount DataMan barcode readers, B3Servis' products are able to read both 1-D and 2-D codes at the same time while the large field of view and ability to read codes in any orientation eliminated requirements to position each leaflet in a specific location and direction. In addition to its user-friendliness, DataMan barcode readers can easily keep pace with the high speed of the printing machines and are, with 45 reads per second, even faster than originally required.

GLOSSARY

1-D barcode	Also known as a linear barcode, a machine-readable code representing data in the widths and spacings of parallel lines. Also see Aztec, Codabar, Code128, Code 39, EAN, Interleafed 2 of 5, Pharmacode, POSTNET, and UPC.
2-D barcode	A machine-readable code that stores data both horizontally and vertically. See also DataMatrix, MaxiCode, and QR code.
Aztec	A type of 2-D barcode also published as ISO/IEC 24778:2008 standard, named after the resemblance of the central finder pattern to an Aztec pyramid. Has the potential to use less space than other matrix barcodes because it does not require a surrounding blank "quiet zone."
Bright field	Producing or using a strongly lighted background.
C-mount lens	A type of lens mount commonly found on 16 mm movie cameras, closed-circuit television cameras, machine vision cameras, and microscope phototubes.
Check digits	A form of redundancy check used for error detection on identification numbers that is analogous to a binary parity bit used to check for errors in computer-generated data. Consists of a single digit (sometimes more than one) computed by an algorithm from the other digits (or letters) in the sequence input.
Chemical etching	A form of direct part marking; the subtractive manufacturing process of using baths of temperature-regulated etching chemicals to remove material to create an object with the desired shape.
Clocking pattern	Provides a count of the number of rows and columns in a 2-D barcode.

CMOS digital sensor	An optical sensor manufactured similar to the creation of microchips; the result is camera image sensors that are generally cheaper to manufacture than competing charge coupled device (CCD)-based sensors.
Codabar	A discrete, self-checking 1-D barcode that allows encoding of up to 16 different characters, plus an additional four special start and stop characters, which include A, B, C, and D.
Code 128	The most robust 1-D barcode type. The number 128 refers to the ability to hold any character of the ASCII 128 character set. Includes all digits, characters, and punctuation marks, making it compact and very powerful as it enables diverse storage of data.
Code 39	Also known as "3 of 9 Code," was the first 1-D barcode symbol to use numbers and letters. This variable-length barcode is self-checking, so a check digit normally is not necessary, but recommended. Gained popularity due to its ability to encode up to 43 numbers, letters, and other characters. Still widely used, especially in non-retail environments.
Dark field	Illumination of the field of view from the side so that the object is viewed against a dark background.
DataMatrix	A 2-D code that can encode of large amounts of data (up to 2,335 alphanumeric or 3,116 numerical characters) and use an error-correction system to read codes that are as much as 40% damaged. Made up of black and white cells in a square or rectangular pattern, a finder pattern, and a timing pattern.
Diffuse dome lighting	A lighting arrangement where the light is directed into a hemispherical, usually white, enclosure that reflects the light backwards on an object without bright spots, or hot spots, common to direct bright field lighting.
Direct part marking (DPM)	A process to per manently mark parts with product information including serial numbers, part numbers, date codes, and barcodes. This is done to allow the tracking of parts through their full life cycle. See also chemical etching, dot peen, and laser marking.

Discrete I/O	Refers to a wiring method where the conductor directly connects a transmitter to a receiver without encoding, protocols, or other common methods used to create digital networks.
Dot peen	A direct part-marking method composed of a carbide or diamond stylus that rapidly actuates and makes a series of small dots on a material's surface. The stylus moves along the surface and forms marks including alphanumeric characters and machine-readable codes and logos.
EAN	Standing for International Article Number (EAN), EAN-8 is the European counterpart of the UPC-A symbol. The main difference between them is that the EAN-13 encodes an extra digit of data to make a total of 13. The first two digits of the barcode identify a specific country, and the check digit is the last number of the second group of six digits. EAN-8 is the EAN equivalent of UPC-E in the sense that it provides a short barcode. Set in two groups of four numbers, it is composed of two flag digits, five data digits and one check digit. This is primarily used on small packaging where space is limited.
Ethernet	A system for connecting a number of computer systems to form a local-area network, with protocols to control the passing of information and to avoid simultaneous transmission by two or more systems.
Ethernet/IP	An Industrial Ethernet network that combines standard Ethernet technologies with the media-independent Common Industrial Protocol (CIP).
Finder pattern	Also called a locator or L pattern, it lies along two sides of a 2-D code and helps the reader to locate and determine the orientation of the machine-readable code.
GS1	A neutral, not-for-profit, international organization that develops and maintains standards for supply and demand chains across multiple sectors.
Guard pattern	Usually a pair of bars in a 1-D barcode that indicate the beginning and end of specific data strings.

Hotbars II	An image processing algorithm used with Cognex® DataMan vision-enabled barcode readers that dramatically increases the decoding speed of damaged or poorly presented 1-D linear barcodes.
Hotspot	A bloom or section of an image where all pixels in that area have maximum intensity values, hiding any image data that may have otherwise been found in that area of the image; usually caused by lights reflecting off shiny surfaces during imaging.
Vision-enabled barcode reader	Unlike traditional laser scanning, an vision-enabled barcode reader uses an area array sensor similar to those found in digital cameras and can read both 1-D and 2-D barcodes.
Inkjet printer	A computer peripheral that sprays ink onto paper, labels, boxes, and other media.
Interleaved 2 of 5	A continuous two-width 1-D barcode symbology commercially used on 135 film, for ITF-14 barcodes, and on cartons of some products, while the products inside are labeled with UPC or EAN.
Laser marking	A direct part-marking method that labels materials with a laser beam by engraving, removing, staining, annealing, and foaming an object's surface.
Laser scanner	1-D barcode reader that directs a laser point source across the code by passing the beam through a rotating prism or mirror.
Liquid lens technology	Liquid lenses use electrical charges to change the shape of the interface between two different liquids, oil and water. This bends the light and brings the image into focus. Unlike traditional zoom lenses, liquid lenses do not move or use motors and therefore are much more robust than mechanical or spinning optics.
Margin	The margin is a blank space around a barcode that separates the barcode from neighboring graphics, shapes and textures. Also see Quiet zone.

MaxiCode	A fixed-size code that holds up to 93 data characters composed of a central bull's-eye locator and offset rows of hexagonal elements. Created by United Parcel Service to allow quick, automated scanning of packages on high-speed conveyor lines.
Microprocessor	An integrated circuit that contains all the functions of a central processing unit of a computer.
Modbus TCP/IP	A serial communication protocol published by Schneider Electric®. Each device on a Modbus network is given a unique address (similar to Ethernet/IP) and as long as the devices are on the Ethernet network they are able to send Modbus commands.
Pixels per module (PPM)	Determines how many pixels are in one cell or module of the code.
Pharmacode	Also known as Pharmaceutical Binary Code, a barcode standard used in the pharmaceutical industry as a packing control system. Designed to be readable despite printing errors.
Postal Numeric Encoding Technique (POSTNET)	Barcode used by the United States Postal Service to automatically sort mail. Unlike most other barcodes in which data is encoded in the width of the bars and spaces, this 1-D barcode encodes data in the height of the bars.
PROFINET (Process Field Net)	An standard for industrial automation using a computer network. Typically used with Siemens® PLCs.
Quick Response (QR) code	Codes containing square blocks of black cells on a white background with finder patterns in the top left, top right, and bottom left corners. Developed to track parts during vehicle assembly but now commonly used in printed marketing materials.

Quiet zone	A blank space around a barcode that separates the barcode from neighboring graphics, shapes, and textures. See also Margin.
RS-232	A standard for serial communication transmission of data.
S-mount lens	A standard lens mount that uses a male metric M12 thread with 0.5 mm pitch on the lens and a corresponding female thread on the lens mount; thus an S-mount lens is sometimes called an M12 lens.
Statistical process control (SPC)	Statistical methods used to monitor and control a process to ensure that it operates at its full potential.
Universal Product Code (UPC)	A variety of 1-D barcodes widely used in the United States for tracking trade items.
Universal Serial Bus (USB)	A common interface that enables communication between devices and a host controller, such as a personal computer (PC).

COGNEX BARCODE READERS: ANY CODE, EVERY TIME

Fixed-mount Barcode Readers

DataMan industrial fixed-mount barcode readers combine unmatched code reading performance and ease of use in an extremely small form factor. These fixed-mount readers offer best-in-class performance with patented Cognex 1-D barcode and 2-D matrix code reading software algorithms. The flexible optics, lighting options, easy setup and quick deployment make them ideal for the most demanding applications.

Handheld Barcode Readers

DataMan industrial handheld barcode readers provide unmatched performance for direct part marks (DPM) and label-based applications, where integration, ruggedness and the ability to read challenging marks quickly are essential to your success. These handheld readers have field interchangeable communication modules and each reader can be configured to meet specific communication needs.

Mobile Terminals

The MX series vision-enabled mobile terminals allow you to leverage the latest mobile device technology for your industrial barcode reading applications. The flexible design accepts a variety of both current and future generation mobile devices and augments their capability in a fully ruggedized housing tough enough to stand up to the most challenging environments.

2-D DataMatrix Verifiers

DataMan barcode verifiers ensure DataMatrix code quality and contract compliance. Easy-to-use and reliable, DataMan verifiers enable quality control solutions for applications that require the highest read rates for 2-D DataMatrix codes—critical to product traceability.

HTE AUTOMATION
a division of HTE Technologies

ST. LOUIS
2021 Congressional Dr.
St. Louis, MO 63146
Tel: 314-731-4444

KANSAS CITY
8008 Reeder St.
Lenexa, KS 66214
Tel: 913-440-4477

SPRINGFIELD, MO
4319 S. National Ave.
Springfield, MO 65810
Tel: 417-724-2231

BLOOMINGTON, IL
1701 E. Empire St.
Bloomington, IL 61704
Tel: 217-615-4440

www.hteautomation.com

COGNEX

Companies around the world rely on Cognex vision and barcode reading to optimize quality, drive down costs, and control traceability.

Corporate Headquarters
One Vision Drive, Natick, MA 01760 USA
Tel: +1 855-426-4639

www.cognex.com