WHITEPAPER

A Brief Guide to Bar Code Printing

DATAMAX®

Introduction

Bar coding is an automatic identification and data collection technology commonly referred to as Auto ID. The most visible and familiar bar codes are the ones found in retail and grocery stores. These bar codes (parallel, adjacent bars) are found on many product labels or printed on the products themselves.

Auto ID technology has been in use for more than 30 years especially with shipping/receiving, warehousing and manufacturing companies.

As technology advanced to where the personal computer has become the indispensable tool for business operations Auto ID technology has gained global acceptance to provide immediate and accurate data collection.

Over the years many industries have development standards to ensure product identification and compliance within their respective industry such as HIBCC (Healthcare), HAZMAT (Chemical), POSTNET (Postal) and AIAG (Automotive).

What are the Advantages of Bar Coding?

Improved Data Accuracy
Bar coding provides virtually perfect data accuracy versus manual data entry. Studies have shown manual keying of data has an error rate of 1 error for every 300 characters entered versus 99% accuracy with integrated bar coding systems.

Faster Data Input and Handling
Data moves directly, and immediately, to a computer or other device for processing and storage.

Cost Benefits
Better customer service, capital and inventory management, faster response times, lower equipment and labor costs.

Flexibility
A wide variety of bar code equipment, label materials and experienced companies are available to assist in implementing Auto ID systems.

Bar Code Applications

There are many industries and applications utilizing bar coding technology. The following industries are just a few that have implemented bar coding technology:

- Healthcare
- Compliance Labeling
- Government
- Manufacturing
- Transportation and Logistics
- Shipping and Receiving
- Ticketing
- Enterprise Resource Planning
- Retail and Grocery Stores
- Supply Chain Management

The following are a few examples of applications using bar coding technology within these industries:

- Admissions
- Inventory Control
- Driver Licenses
- Drum Labeling
- Baggage Tags
- Food Items
- Sporting Events
- Pharmacy
- Order Fulfillment
- Postal Services
- Pallets
- Boarding Cards
- Clothing
- Theaters
- Radiology
- Shipping
- Auto Registration
- Containers
- Work in Progress
- Electronics Labeling
- Loyalty Programs
- Blood Bank
- Parts Marking
- Asset Tracking
- Cargo/Bin
- Shelf Labeling
- Jewelry
- Ski Resorts

Assessing Your Bar Code Labeling Needs

First you need to determine your labeling application requirements, and what your labels must accomplish. Then you can decide on what bar code type (symbology), label stock type, labeling software, and bar coding hardware (printer, scanner, etc) is best suited for your application.

What Your Labels Must Accomplish

Answer the following questions:

> Do you have compliance labeling requirements? For example, industries often specify label size, configuration, content, print quality and the various symbologies (bar code types) to be used in printing the labels. You need to know if your industry has any standards or requirements for properly printing labels. Some industries assess penalties if the labels are improperly printed per their standards.

> What types of labels are required? Determine whether both product and shipping labels are required and if so, then how many labels are needed for each item or package.

> What is the size, shape, color and material needed for each label?

> What information is required on the label. Part number, quantity, vendor number, prices and so forth may be needed. Determine also which information should be represented by bar codes and which by human readable letters or numbers.

> How should the label be configured? Determine the location of the bar codes, human readable characters or graphical images on the label. Identify the font (text type face or style) to be used for all human readable text.

> Where on the product or package will the label be placed? Also determine the type of surface involved. Is it smooth, hard, rough, porous or curved?

> In what environment will the labels be used or exposed to? Determine how long the label will be used or needs to last. Will the label be exposed to sun, water, chemicals or temperature extremes? Will the bar code reading device rub up against the label?

> Does the label have a security function? Determine whether the label should be removable, permanent, tamper resistant or covered by a protective coating.

Symbologies, or Bar Code Types

Although there are many symbologies used to create bar codes, most symbologies produce symbols with several aspects in common. This section is intended to give you a basic technical overview, of symbologies or bar code types so you can understand the terminology when you decide to implement bar coding technology.

Bar Code Contents

> Bars and spaces are known as the "elements" of the bar code. They are grouped together to make "characters" that each represent a number, letter, punctuation mark or other character. Bars must be dark enough so they do not reflect back a bar code readers light, while the spaces within the bar code and the background around it must be clear and reflective enough to be distinguishable from the bars by the bar code reading device.

> The "density" of the bar code is the number of characters that can be represented per linear inch and is usually expressed in characters per inch or CPI. The higher the density, the more information a bar code can represent within a given space.

Bar Code Format

> Clear spaces, known as "quiet zones" or margins, are placed before and after the bar code symbol. These quiet zones ensure that only the complete bar code is read.

> "Start" and "Stop" characters or patterns indicate the beginning and end of the bar code symbol and sometimes even provide clues as to the direction the bar code is being read. "Bi-directional" bar codes can be read from either of two directions. Most bar codes are arranged in a "linear" format, a single row of bars and spaces that usually allows for bi-directional reading. These are often referred to as "one dimensional" bar codes. "Two dimensional' bar codes encode information in two directions and they require special readers. These bar codes come in two basic formats called "stacked" symbologies and "matrix" symbologies.

> "Check characters" or "check digits" are sometimes used to help determine that the correct information is read from a bar code. "Self checking" bar codes prevent a printing defect from causing similar characters to be substituted for each other.

> "Data" or "application" identifiers are sometimes used to indicate the general category or intended use of the information contained within a bar code.

> Symbologies that create "discrete" codes separate each character by spaces that carry no information. Discrete characters can be decoded independently and do not require the highest print quality standards. Symbologies that create "continuous" codes use every space within the bar code to carry information. Continuous codes can convey more information per inch than discrete codes but have slightly higher print quality requirements.

> Bar codes are most often displayed "horizontally" and in this orientation are known as "Picket Fence" codes due to their resemblance to a picket fence. However they may also be displayed "vertically" and these are referred to as "Rotated" or "Ladder" codes due to their resemblance to the rungs of a ladder.

If you plan to use bar codes for internal use, select the bar code symbology that best suits your application. However, if your labels must satisfy customer or industry compliance standards, you must use the symbology designated by those standards.

Common Bar Code Symbologies

Universal Product Code - UPC

The Universal Product Code, or UPC, is widely used in retail, packaging, counting and data processing applications. There are several versions of the basic symbology in use, including the EAN standards for international applications.

Characters:	Only numbers from 0 to 9 are represented.
Length:	Fixed at 12, 6 digits.
Format:	Linear, continuous bar code.
Reading:	Bi-directional.
Checking:	Self-Checking and Check Digit incorporated into the bar code.
Required size:	A 12 digit full sized bar code requires about 1.5 inches horizontally and 1.0 inches vertically.
International:	The European Article Numbering, EAN, standard is UPC's international counterpart.

UPC A

UPC E

EAN-13

EAN-8

Interleaved 2-of-5

Interleaved 2 of 5 is a high-density code used in warehousing, product/container identification, general industrial and automotive applications. Its name indicates each bar code character contains five bars, two of which are wide. Both bars and spaces convey information. This symbology is very useful for numeric messages less than 10 digits long.

Characters:	Only numbers from 0 to 9 are represented.
Length:	May vary but must have an EVEN number of digits.
Format:	Linear, continuous bar code.
Reading:	Bi-directional.
Checking:	Self-Checking and may have a Check Digit incorporated into the bar code.

Interleaved 2 of 5

Code 39

Code 39 is widely used in industrial, medical and government applications, including photo finishing, high speed sorting, inventory handling, aluminum, electronics, telecommunications and furniture. It is endorsed by several industry trade groups including the Automotive Industry Action Group AIAS, the Health Industry Business Communications Group HIBCC and the U.S. department of Defense DOD. Its name signifies each bar code character is composed of nine elements, three of which are wide.

Characters:	Represents ALL 128 alpha-numeric characters from the ASCII character set.
Length:	Variable.
Format:	Linear, discrete code.
Reading:	Bi-directional.
Checking:	Self-Checking. May have a Check Digit incorporated into the bar code but is not normally used.

Code 39

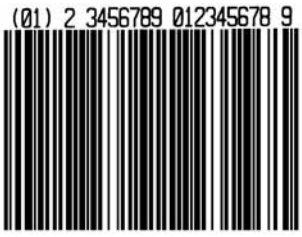
Code 128

Code 128 applications include general industrial, inventory control and container markings. It is used as the basis for the international language known as Application Identifiers, or AI. As its name signifies, this high-density code can represent the entire 128 character ASCII character set, including any character found on a PC keyboard. The code offers high versatility and high data security (reliability). Code 128 is endorsed by the HIBCC and the Uniform Code Council, UCC.

Characters:	Represents ALL 128 alpha-numeric characters from the ASCII character set plus any keyboard character.
Length:	Variable.
Format:	Linear, continuous code.
Reading:	Bi-directional.
Checking:	Self-Checking and may have a Check Digit incorporated into the bar code.

Code 128

Health Industry Bar Code (HIBC)



UCC/EAN Code 128

Codabar

Codabar applications include inventory control, libraries, blood banks and photo finishing. Each character is represented by a group of four bars with three included spaces. The ability to use four different start/stop characters at either end of the bar code symbol allows multiple types of information to be encoded.

Characters:	Decimal number digits and several ASCII symbols.
Length:	Variable.
Format:	Linear, discrete code.
Reading:	Bi-directional.
Checking:	Self-Checking and optional Check Digit.

Codabar

Reduced Space Symbology (RSS)

The new Reduced Space Symbology (RSS) addresses long-standing business needs not met by traditional bar coding standards/symbologies. In the past, bar coding has been used in every application except those that were faced with severe space constraints, where items to be labeled were too small for the current standards, or where there was a need to capture additional (variable) information in a limited space. After a review of currently available technologies and symbologies, the European Article Network/Uniform Code Council (EAN.UCC) determined that currently available tools were too niche-focused to address these space constraints across a variety of industries. Therefore, a development effort began for a new symbology that would be relevant across industries and applications. RSS is the result of that development effort. The RSS family includes RSS-14, RSS Limited, and RSS Expanded as well as a Composite Component (see RSS Composite section). The new RSS and Composite Component symbologies will expand the capabilities of the current EAN.UCC encoding tool set to identify items unable to be marked with larger linear symbologies because of size restrictions. The EAN.UCC has been issued patents on RSS and has placed the symbology in the public domain to facilitate its adoption throughout various industries.

RSS-14

RSS Stacked

RSS-14 Truncated

RSS Limited

RSS Omni-Directional

RSS Expanded

Two Dimensional Stacked Symbologies

Two-dimensional "Stacked" Symbologies are relatively new to bar coding applications. These bar codes are designed to include the largest amount of machine-readable information in a small area. In other words they feature very high information densities. Symbologies such as PDF417, 16K and Code 49 produce bar codes containing rows of smaller linear bar codes, each stacked on top of one another in a rectangular fashion, hence the term "stacked" symbologies.

Two-dimensional symbologies require the entire bar code to be scanned as a whole before they can be decoded into useful information. Two dimensional bar symbologies typically utilize sophisticated "Error Correction Codes", or ECC, that not only detects data errors but can also correct them; making two-dimensional bar codes very secure and reliable even in adverse environments.

"Matrix" symbologies are also two dimensional but their elements are NOT stacked rows of linear bar codes but instead various patterns, or a "Matrix", of tiny elements such as hexagons or squares or rectangles. "Matrix" Symbologies are notable for their very high information densities. Matrix bar codes usually contain a "finder pattern" that allows the reader to distinguish them from other bar codes and to determine their exact orientation for decoding. Most matrix reading devices utilize either CCD or camera scanning technologies to read the symbols.

RSS (Composite)

The RSS Composite Component is distinguished by its ability to encode a large amount of data in a small area. It is not a stand-alone symbology. Rather it is a two-dimensional symbol that is used in conjunction with other EAN.UCC linear symbols that encode EAN.UCC System Keys. While Composite Component is a two dimensional bar code, it is not a traditional two-dimensional symbology. Composite Component is a stacked linear bar code that is bi-directionally decodable and can be read with laser scanners. The Composite Component can be used to provide additional supply chain or variable data while allowing for the co-existence of symbologies already being used.

RSS-14

RSS Stacked

RSS-14 Truncated

RSS Limited

RSS Omni-Directional

RSS Expanded

PDF-417

PDF417 is a very high capacity 2-dimensional stacked symbology introduced in 1990. It obtained AIM standardization in 1994 and is now supported by all the major printer and scanner manufacturers.

The use of PDF417 has been increasing in popularity because of its capability to store very large amounts of data reliably.

PDF is an acronym that stands for "Portable Date File". It can encode over 1800 alphanumeric characters or over 2700 numeric characters. It can be used to encode all the necessary information about a person, product, document or package. The capability to encode large amounts of data and have that information travel with the labeled item has spurred on numerous new applications that are not possible with traditional linear bar codes. PDF417 is recommended in both the transportation and automotive industries for shipping labels, bills of lading information and "Paper EDI".

PDF-417

Matrix Symbologies

"Matrix Symbologies" are symbologies that use a binary array of either squares, hexagons or circles to encode data. The resulting increase in data encoding capacity allows for a significant level of error correction and date redundancy. All matrix symbologies have a distinctive "finder pattern" that allows the reading device to locate them when being scanned.

Data Matrix

Data Matrix is a relatively recent 2-dimensional bar code development. This code has a high data capacity that is most commonly used for product identification and lot tracking of small components. Several organizations have recommended the use of Data Matrix for specific applications. An example of this is the "EIA" of the Electronics Industry Association, "SEMI"- the Semiconductor Equipment and Materials International association and the "AIAG"- Automotive Industry Action Group. All have been coordinating efforts to create an inter-industry series of compatible standards for wafer, electronic component and product marking. For these organizations Data Matrix is desirable because of its high data capacity, its variable sizing capabilities and its ability to withstand harsh environments.

The healthcare industry has also found several applications including lot tracking of pharmaceuticals and specimen identification in biomedical testing.

Datamatrix

MaxiCode

MaxiCode was introduced by the United Parcel Service and developed specifically for high-speed package sortation applications. The purpose behind the creation and use of MaxiCode is to be able to encode all the necessary information about a package and allow that information to travel with the package. In essence, this information gives the package a "personality".

MaxiCode

While the previous symbologies are some of the common types used, there are many more available. Here are a few more samples:

Code 93

USD-8

Aztec

Postnet

UCC/EAN Code 128 Random Weight

Telepen

QR Code

MicroPDF417

Label Stock Type

Media, or consumables, refers to the actual materials (paper and inking ribbons) used to generate a printed label. It is extremely difficult to list and explain all the different types of label stock, sizes, ribbons, etc in this document. We will cover the basics of label stock with regards to the laminates and adhesives. If you would like a more in-depth discussion on label stock please refer to our Overview on Label Stock White Paper or call our Label Supplies Specialist at the phone numbers listed at the end of this document.

Facestocks, Laminates and Adhesives

"Facestocks", "laminates" and "adhesives" must all be carefully matched in order to perform correctly within your labeling application. "Facestocks" are the actual base material that makes up the label itself. "Laminates" represent special coatings or films that can be applied to the "Facestocks". There are literally hundreds upon hundreds of different combinations available.

Facestocks:

> Paper

Paper is the most commonly used facestock and is usually the lowest in cost. It is available in many types, thicknesses, colors and sizes. However, paper can be damaged by light, water, dirt and chemicals and may be torn or scraped. Paper labels perform best in controlled environments and in applications such as product labeling, pricing and shipping.

> Synthetics

Synthetic facestocks include, but are not limited to, polyester, polypropylene, vinyl and mylar. These stocks can provide very high print quality and are more likely to perform better than paper for labels exposed to harsh environments or subject to hard use. Polypropylene facestocks are available in many forms for a wide array of applications. Polyester is used in applications subjecting labels to very hard use and to extreme environmental conditions. Vinyl facestocks are also very durable, especially on curved or irregular surfaces.

Laminates:

Many different laminate coatings can be applied to facestocks to improve their performance in many different applications. Special top coatings are available that increase imaging performance and durability. Other laminate coatings offer better performance with a wide variety of adhesive materials.

Adhesives:

Many combinations of adhesive materials are available. Some applications require permanent labels that resist exposure to temperature extremes, high humidity, chemicals or outdoor use. Other labels must be easily removed without tearing, damaging the item or leaving a residue. Labels may also need to removed and then re-applied or to be tamper-resistant or tamper-evident. Many surfaces are difficult to label and require specific adhesive formulations. There are two common types of adhesive materials used today that are:

> Rubber based Adhesives

These adhesives are useful for quick sticking applications but may weaken when exposed to cleaning solvents, chemicals or ultraviolet light.

> Acrylic based Adhesives

These adhesives come in a wide range of properties. Some allow clean, easy removal without leaving residues. Others may require some time period in which to set completely but hold permanently in a wide variety of conditions. Some can be used in label applications where the labels will not come off in one piece.

Preparing a Bar Code Printing System

Once you have determined your labeling requirements, the layout and formats of the labels you require and the specific bar code symbologies appropriate for your application, it is time to prepare your bar code label printing system. You must consider your options for software and bar code label printers.

Label Printing Software

There are many bar coding software packages available. Before choosing one, test several for compatibility with your current operations and for the capabilities and labeling needs your application requires. Consider the following issues:

1. Does the software fully support the bar code symbologies you need to use?

2. Does the package provide for multiple text fonts, portrait and landscape printing and the ability to import custom graphics, logos and type styles?

3. Does the software provide database import and export capabilities?

4. Does the software provide a "What You See Is What You Get" or WYSIWYG interface? This is critical to allow you to view complete labels on your computer monitor, including bar codes, text, logos, line art and graphics, as they would appear on the printed label.

For more information on software packages that support bar coding applications please visit the Datamax Software Resource Directory at www.datamaxcorp.com/applications/softwarepartners/

Methods of Printing Bar Code Labels

The most popular bar code label printing methods are thermal transfer and direct thermal.

Direct Thermal

Direct thermal printers contain a thermal print head that applies heat energy to a specially coated facestock that turns black when heated to create the required images. Direct thermal saves money by not requiring the use of an inking ribbon. However, the coated facestock is more expensive than non-thermally coated facestocks and is very sensitive to temperature, light, water, chemicals and hard use. The life expectancy of direct thermal labels is usually less than one year. Direct thermal labels perform best for short term or indoor uses such as products with short shelf lives, shipping or indoor inventory control.

Thermal Transfer

Thermal transfer printing is the most widely used method for in-house bar code label printing. A thermal print head is used to generate heat energy that in turn transfers the ink from a ribbon onto the label facestock, creating the required images. This method improves upon direct thermal printing in several ways. A wide variety of both paper and synthetic facestock materials may be used with both black and colored ribbons. Print quality is very high; the image is long lasting and durable. Bar codes can easily be read by both infrared and visible light reading devices.

A wide variety of thermal transfer ribbons are available and it is very important to match your ribbon selection to your application. There are three basic formulations of thermal transfer ribbons that are:

> "Wax-based ribbons" are low in cost and suitable for most applications. Label images may be scratched in use or smear if the temperature is too high.

> "Resin-based ribbons" produce label images that are much more resistant to wear and extreme conditions. Some resin inks used on certain facestocks can withstand temperatures over 1000 degrees. However, resin-based ribbons tend to be rather expensive.

> “Wax-resin ribbons" produce label images with higher durability than wax-based ribbons but are lower cost than pure resin-based ribbons.

Whichever ribbon or ribbons you use, be sure your media supplier has assured you that the ribbon:

> Has a combination of tensile strength and smooth surface that will allow for high-speed printing but will not tear, stick or slip during the actual label printing operation.

> The ink is of the proper type and formulation and can be applied uniformly to the selected facestock and that it binds well.

Printer Considerations

In most cases, your thermal bar code printer will need to be linked to a host, such as a PC or mid-range or mainframe computer. This configuration usually takes some effort to install. Some computer systems require a specific communications interface between the computer and the printer. Check carefully whether such an interface is required and if your printer vendor supplies such an interface. (Note: Datamax is the only printer manufacturer that offers a true intelligent bar code printer, which means you don't need a PC computer to implement a bar coding system. Please see the Datamax Intelligent Bar Code Printer White Paper). Always consider the following when selecting your printer:

> Communication interfaces. You may need serial, parallel, USB, Ethernet, coax, twinax or others.

> Memory. Your printer needs sufficient memory to support your application and label software. Make sure that the printer you select provides options for additional memory and is supported by the software package you intend to use.

> Print Speed. You may need from 2 to 12 Inches Per Second (IPS) print speed for your label generation requirements. However, even more important is LABEL THROUGHPUT, measured in labels per minute. Make sure that, with your representative labels being generated, your printer of choice can produce the required minimum number of labels per minute for you.

> Print Head Resolution. This is the number of DOTS PER INCH the print head can physically print and is measured in DPI. Most of your applications can be handled by 203 DPI so don't be willing to spend more for higher resolutions if they are not needed. However, if you need to print tiny bar codes and tiny sized text characters or Two Dimensional bar code, then a higher resolution such as 300 DPI may be required.

> FONTS. Make sure your printer has a good set of built in fonts but that it also supports additional fonts by using memory cards or computer chips. It should also support the downloading of new fonts via software. You might also consider the capability to support multiple languages.

> Special Media Handling. Your application may require internal or external label rewinding, label peeling, label cutters, ribbon savers or other special functions. Make sure that the printer you choose supports all these functions either as standard (not usual) or as options.

Summary

Bar coding has been part of the technology infrastructure of business for many years. While the technology is not new, uses for bar coding keep expanding from what has become traditional applications - inventory management, retail check out - to new, diverse applications where bar coding technology is only beginning to become relevant. New applications exist in many industries, such as healthcare, ticketing and apparel. There are also new applications in industries that have used bar coding technology for many years. One example of this is in manufacturing, where bar codes have been used for years for required compliance labels but are now being used for work-in-process tracking to allocate costs and for inventory management.

Regardless of your labeling needs, Datamax has encountered the application before. Our staff of labeling and printing experts can you assist you in developing the most appropriate bar code labeling solution. The basic tenets of bar coding are simple, and Datamax Corporation has been in the bar code world for many years. In fact, Datamax has been in business for 25 years bringing the most innovative printing solutions to the marketplaces that need them. Datamax Class printers are used in a variety of applications in facilities around the world in industries such as automotive, postal, healthcare, retail and transportation to realize the benefits of bar coding.

The value that bar coding brings to an application depends entirely on its implementation. A bar code cannot drive costs out of a process on its own. However, used correctly bar coding can increase efficiency and remove virtually all aspects of human error by automating the entire data collection process.

There is quite a lot to consider and decide upon when putting together your own bar code label printing system. We hope this brief white paper has been somewhat helpful but we understand that, at best, it most likely answers only some of your most basic questions. However, Datamax has a network of resellers, VARS and OEMs worldwide so no matter where you work or what application you need to implement, Datamax knows someone who can help you.

Please visit www.datamaxcorp.com for more information on Datamax products and solutions.

Datamax specializes in the design, manufacture, and marketing of products for bar code and RFID labeling including thermal demand printers, label, ticket and tag materials, and thermal transfer ribbons. Headquartered in Orlando, Florida, Datamax has sales representative offices in Singapore, China, and Harlow, England, as well as label converting and preprinting facilities in Robinson, Illinois. Datamax markets its products exclusively through a network of resellers in more than 100 countries worldwide.

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