Introduction Into Barcodes

BY

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An introduction to the world of barcodes. Written for the Business Owners and Software Developers who want to get basic understanding of barcodes.

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Preface

1. Introduction

Gone are the days when you used to go to a store, pick items from a shelf and reach the point of sale; cashier used to cast a look upon the items, check the items' prices from the list and add it to the total bill. This was time consuming, irritating for the customers and often times the price and product information entered manually was faulty. Advancements in technology has affected virtually all walks of everyday life; Likewise, computerized point of sale systems were introduced and if there was anything left in completely automating POS, barcodes were introduced.

This book has been written for the business owners who want to get basic insight about the barcodes. Those, who want to know what barcodes actually are, and what their different types are. After reading this book, business owners will be able to decide that which barcode suits their business needs. This book is also intended towards the software developer and professionals who are working on a project which integrates barcode for example, point of sale system, medical image system or any departmental store application. After reading this book, IT professionals will be able to make a decision about the barcodes to use based on the requirements of the project.

1.1 What are barcodes?

Barcode is nothing but a piece of paper pasted on items. You would have seen patterns of black and white vertical lines on items in stores, books, hardware items etc. These lines may seem oblivious to you but they contain large amount of information regarding the product on which they are pasted. But with little research you can have an idea what are several types of barcodes, what their functionalities are and what are their advantages and disadvantages. Diverse algorithms are used to

1.2 Why use barcodes?

An important question exists that needs to be answered before dwelling into the details of the barcodes. Following are some of the reasons:

- Barcode encoding and decoding is extremely fast and can save lots of time that is spent in manually encoding and decoding information.
- Barcodes are secure way of encoding information and chance of faulty information and human error is minimal.
- Barcodes nowadays are extremely cost effective; the encoding hardware and scanning devices have become cheaper and reliable.
- Barcodes helps in decision making process by providing processed data using specialized programming algorithms.
- Process automation is the biggest advantage that comes with barcode implementation in point of sale systems.

1.3 What are applications of barcodes?

Almost every industry is employing barcodes for automating their product information storage and retrieval purposes. Following are some of the general application areas of barcodes.

- Whole sale dealers and retail shop owners make use of barcodes for product identification.
- Medical and surgical industry places barcodes on medicine, surgical equipment and diagnosis machinery.
- Shipping and marine industry make use of barcodes for secure shipment and product information.
- Electronic and computer industry employ barcodes on electronic devices and hardware components.
- Postal industries use barcodes for efficient parcel routing and mail delivery across the board.

Apart from the above mentioned applications, there are hundreds of other areas where barcodes are being widely and successfully used.

In the next chapter we are going to explain what are the two major categories of barcodes and how they differ from each other, pros and cons of both and finally the usage of both barcodes.

2. Categories of barcodes

Barcodes have now become an essential part of almost every Brick and Mortar Company. You will rarely find a product without a barcode Tag. Different types of barcodes are used for different purposes in business sectors. There are several advantages of using barcodes as compared to manual data entry. Typical usage of barcodes include

- Tracking sale and purchase of large number of items in an inventory.
- Barcodes are pasted on sports tickets which allow one to enter a sports arena.
- Barcodes are often placed on gift tokens that when decoded tells which gift that token corresponds.

Types of barcodes

There are two major types of barcodes

1- One Dimensional or Linear Barcodes
2- Two Dimensional Barcodes

2.1 One Dimensional Barcodes

One dimensional or linear barcodes are commonly referred as first generation barcodes. These barcodes consist of vertical lines at specific gaps resulting in a particular pattern. Hardware scanners are used to scan these patterns and decode the information stored in those particular patterns. These barcodes are also commonly called discrete, one dimensional or UPC barcodes.

Advantages of Linear Barcodes

- In linear barcodes, vertical lines are used to store data; hence data is generated in one direction which is easier to generate as compared to generating data in multi-dimensions.
- Linear barcodes are easier to scan. Just like barcode generation, barcode decoding is also done in one direction which is easier to perform.
- No special hardware or software is required to scan these barcodes and a simple and inexpensive scanner can be used to generate and scan linear barcodes.

Disadvantages of Linear Barcodes

- Linear barcodes can only store small amount of data. In order to store large amount of data in linear barcodes, it has to be stretched horizontally with additional vertical lines and spaces, resulting in large barcodes.
- Barcode, once distorted cannot be scanned correctly. Small damage, line at the start or end of the barcode can modify or destroy the data stored in the barcode.

2.2 Two Dimensional Barcodes

2-D barcodes are more complex and store data in the form of a matrix or stack. Stacked 2-D barcodes contain data in the form stacks of linear barcodes whereas matrix 2-D barcodes store data in the form of hexagonal, square or circular cells. They can store data in both vertical and horizontal direction.

Advantages of 2-D barcodes

- These barcodes can store much larger amount of data ranging up to thousands of alphanumeric characters.
- Error correction formula can be embedded into barcode which helps in the retrieval of data in case barcode is damaged up to 15 to 20%.
- Variety of data can be embedded into these barcodes such as numeric, binary, text and Unicode data.

Disadvantages of 2-D barcodes

- Specialized hardware and software scanners are required to generate and decode these barcodes which can be expensive.

- Complex algorithm needs to be designed for 2-D barcodes which make things much complex as compared linear barcodes.

3. One Dimensional/ Linear Barcodes

In the last section we explained what two major categories of barcodes exist and how they differ from each other. In this section we have explained some of famous one dimensional barcodes along with their history, purpose, advantages, limitations and usage. You may find barcodes that are of your interest or related to your domain of business.

3.1 Code 39

Code 39 is one of the most widely and commonly used barcode type. It is a linear or 1d barcode and is also known as USS code 39, code 3 of 9, Alpha 39, USD-3, and Type 39. Code 39 is capable of encoding all the alphanumeric characters (26 Alphabets and 10 numeric characters ranging from 0 to 9). It can also encode space and six special characters including dollar sign ($), Period (.), minus (-), percent (%), slash (/), plus (+). Asterisk (*) can also be used but only at the start or end of the code.

History

Code 39 was initially designed by two researchers from Intermec, named Ray Stevens and Dr.David Allais in the year 1974. Initial code 39 was created with two wide black bars and a wide space which could encode 40 characters excluding the first or last symbol resulting in 39 total characters. It is for this reason that this barcode is called code 39. The latest code 39 contains 9 bars in total with three wide and six narrow bars.

Purposes

Code 39 has been recognized by ANSI (American National Standards institute) as MH10.8M-1983. It is general purpose and most widely used barcode type. Its basic purpose is to encode small information containing alphabets as well as numeric characters in linear pattern of bars and spaces.

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Advantages

- Wide use of this barcode type makes it portable. This barcode can be encoded and decoded by almost every barcode encoding/decoding equipment.
- Code 39 can encode all 26 Alphabets of the English language and the numerals which was not possible with the previous barcodes.
- It is much more secure and is not prone to faulty encoding and decoding.

Limitations

- It is not suitable for items which require large amount of information to be encoded. In that case, length of the code 39 barcode becomes too large which is not appropriate for encoding as well as decoding.
- Code 39 barcode can be easily damaged and distorted like any linear barcode.

Usage

- Code 39 is commonly used in store items, inventories, badges and similar everyday items.
- It is widely used in health sector and medical equipment.
- Used by the US Defense department (LOGMARS) for the military equipment.
- Used in airline and aviation industry on air plane parts.

Conclusion

Code 39 barcode should be used when small amount of information.

3.2 Code 93

Code 93 barcode is a type of linear barcode used to encode high density variable length data. Code 39 is capable of encoding alphanumeric data along with special characters and is a variable length code. Code 39 can encode all the 26 uppercase alphabets, numeric digits from 0-9 and seven special characters including – (minus), (dot), $(dollar), / (forward slash), + (plus), %(percentage) and SPACE.

Code 93 barcode has been named code 93 due to the fact that it has been divided into a total of 9 modules and it must contain 3 bars and 3 spaces in between. In addition to the aforementioned characters, code 93 can also encode 5 more special characters which enables It to code all the ASCII characters efficiently.

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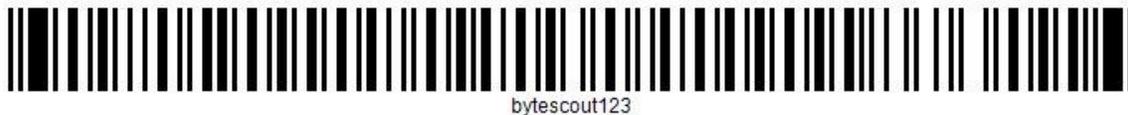
History

In 1982, Intermec started work on improving the already existing code 39 barcode standards in terms of security and data density. Therefore, the company came up with a denser and more robust barcode standard which could encode 5 extra characters as compared to traditional code 39 standard. This new barcode standard was named as code 9 of 3 barcode or in compressed form, code 93.

Purpose

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Code 39 barcode has certain drawbacks particularly in data storage capacity and barcode security, code 39 performed poorly. Keeping in view these problems, work started on code 93 barcode whose purpose was to develop such a barcode standard which has high data density and high security.

Advantages

- Extremely high density barcode. Although it is a type of linear barcodes who do not store large amount of data and have low density, code 93 is high density and is able to store large data in linear patters.
- High security barcode. It has enhanced security features of code 39 which was considered less secure.
- Easy to learn and less employee training is required to encode and decode this barcode standard.

Limitations

- Can store large amounts of data but it is still less dense as compared to the 2-D barcodes.
- Less fault tolerance to damage and distortion. If a certain portion of the barcode is damaged or distorted it is very difficult to recover the data. This is general problem with all linear barcodes.

Usage

- Canada post uses code93 in order to encode customer and product delivery information.

3.3 Code 128

Code 128 is another linear barcode which is widely used in industry and stores. Code 128 is denser than the other linear barcode type i-e code 39. Code 128 can encode all the upper and lower case alphabets and all the numeric characters from 0-9 and all the 128 ASCII character. The higher density of code 128 makes it suitable to store large amount of data as compared to code 139.

This variety of characters has been categorized into three sub-groups or sub-sets. Group or subset A contains all the ASCII characters, uppercase characters, digits and control codes. Subset B contains ASCII characters, upper and lower case characters and digits while the subset C contains numeric data. This versatility of code 128 is the key to its wide scale use.

bytescout123

History

Computer Identics, in the year 1981, designed a barcode type denser than previously used code 39. The barcode type could encode all the 128 ASCII characters. It is for this reason this barcode type is called code 128.

Purpose

The purpose of code 128 was to design such a barcode type which could encode large amounts of linear data in compact form. Previously, code 39 was used to code data but that barcode type was not suitable for encoding large amount of data due to its low density and in order to encode large data the length of the barcode had to be increased which was not a convenient solution. Hence researchers designed code 128 which was more dense and compact and could store large data.

Advantages

- Requires 6 elements to encode a character, 3 bars and 3 spaces which make it compact and concise storing large amount of data in small barcode unlike code 39 which required 9 elements to encode a character
- Can encode all the ASCII characters (including all special characters) unlike code 39 which could encode only six special characters.
- Provides more security over encoded data and minimized chances of error while scanning.

Limitations

- It has four different widths variation for each encoded character. It is not easy to print barcode with four different width variations per element.
- More advanced scanning devices are required to scan these bar codes unlike code 39 which could be scanned with any general scanning device.
- Like other linear barcodes, code 128 is also subjected to distortions and can be damaged easily.

Applications

- Commonly used in shipping industry to identify containers and items.
- Used in packaging and whole sale industry to identify and label variety of whole sale items.
- Widely used in combination with code 39 in all the advanced brick and mortar companies.

Conclusion

If you want linear barcode with complete range of Alphabets, Numeric and ASCII characters, code 28 is the best option. It is compact, concise and can handle large amount of data.

3.4 EAN 13

EAN-13 is a linear barcode type most commonly used outside America, particularly in European countries. EAN-13 is an abbreviation for European Article Number which is now called International Article Number. EAN-13 contains 13 consecutive and fixed digits in total. The first 2, 3

digits of the EAN-13 code represent the country code next 9, 10 digits represent the manufacturer code and the product code while the last digits are the checksum digits. The total 13 digits of the EAN-13 barcode are divided into two equal parts of 12 digits by a guard bar in the center.

History

International Article Numbering Association has designed this EAN-13 barcode type and most of the European countries are using this barcode type. GSI is an international organization for standards. This organization defined the standard for EAN13; however, this type is not used in USA. Initially it was developed as Universal Product Code (UPC) with twelve digits in USA but later on it evolved to 13 characters, 12 digits and 1 checksum for self-checking.

Purpose

Purpose of EAN-13 was to develop a bar code which can be easily and quickly encoded and decoded. It is for this reason only numeric data can be encoded with EAN-13. This numeric-only encoding scheme fits the bill and EAN-13 can be encoded/ decoded quickly, easily and acute angles.

Advantages

- It is a very high density barcode and can encode large amount of information in smaller area.
- The barcode is very easy to read and even a scanner, at an angle as acute as 45 degrees to the surface of the barcode, can easily decode the information
- Wide use of the scanner in Europe makes it very portable and no advanced scanning devices are required to decode the information
- Much suited to fast moving items on automatic machines.
- Checksum digit provided self-checking mechanism.

Limitations

- Can encode only numeric data, not alphabets and special characters.
- Like other linear barcodes, it has very small tolerance for damage and distortion and cannot be scanned in that case.

Usage

- Widely used in Europe on consumer goods such as groceries, DVDs, food items and other similar products.

- Used in production houses where fast encoding and decoding is required owing to its simpler encoding/ decoding technique involving numeric only.
- Due to its capability to be scanned at acute angles, EAN-13 is widely used on point of sales retail stores.

Conclusion

Code13 barcode type should be used in cases where quick and easy encoding and decoding of barcode is required such as retail stores and point of sales.

3.5 EAN 14

EAN 14 stands for European article number 14. EAN 14 is a type of linear barcodes used to store information about traded goods. EAN is implemented on GS1 128, barcode standard with an added A1 (01) which is typically used for encoding GTIN 14 (GTIN: Global Trade Item Number). EAN 14 is a 14 digit numeric barcode. The structure of EAN 13 barcode is as follows.

Few slight variation and other names of EAN 14 are EAN/UCC 14, Case Code, DUN 14, UCC 14.

Structure of EAN 14

EAN 14 consists of a total of 14 numeric digits which are organized in the following pattern.

- The starting two numeric digits are fixed and are called EAN-128 Application Identifier. These digits are 0 and 1. These are not mutable and you don't have to add it these, barcode encode device will automatically append them at the beginning of the barcode.
- The next digits are called packaging indicator which is also known as logistic variant.
- Off the remaining 13 digits, first 12 digits contain the information about the product whereas the last digit is the check digit.

(01)12345678901231

Advantages of EAN 14

- EAN 14 is a linear barcode and can be easily encoded and decoded like most of the linear barcode.
- Automatic check digit provides security.
- EAN 14 encodes only numeric digits which makes encoding and decoding algorithm simple and no lengthy user training is required to understand it.

- EAN 14 can be encoded and decoded by any average scanning barcode and no advanced barcode scanning device is required for this purpose.

Limitations

- Although encoding numeric only data brings simplicity yet it is not suitable if one wants to encode alphabets and special characters.
- Similar to other linear barcodes, in order to store large data the width of the barcode has to be increased.
- The ability to tolerate damage is limited in EAN 14 like other linear barcodes and barcode, once distorted or damage can be successfully decoded.

Usage

- EAN 14 barcode is used in GS1 cartoon or pallets industry.
- EAN 14 barcodes is also used for trading purposes and it is the standard used for encoding global trade item numbers. It is for this reason it is also called GTIN 14.
- Commonly used standard for shipping containers, this is why it is named as UPC Shipping Container Symbol.

3.6 EAN2 EAN5 and Their Usage with EAN13

EAN2, EAN5 and EAN13 all are types of linear barcode used to encode information about a particular product at a checkout point. EAN stands for European Article number which is now known as international article number. In the following section, these barcodes have been explained individual followed by their collective usage.

EAN13

EAN 13 barcode symbology contains 13 digits. 12 digits are the data digits where as one digit is the check digit. EAN13 is particular used in encoding information about the items sold at point of sale system. The information which is stored using EAN13 is called product information number. All the codes encoded using UPC and EAN are commonly referred as GTIN (Global Trade Item Number).

EAN2

EAN2 is a two digit linear barcode like EAN13 which has 13 digits. The most basic use of EAN2 is that it is commonly appended at the right of EAN13 in order to store additional information about a product sold at point of sale systems. Another major use of EAN2 is that it is often used on

periodicals, magazines and books. In periodicals, EAN2 is used to distinguish the periodical in terms of week or month. One digit may represent the week and the other represents month. This is repeated on yearly basis. However if you want to completely distinguish between periodicals on the basis of years as well, you can use another EAN symbology as described below.

EAN2

EAN5

EAN5 is another linear barcode belonging to EAN barcode family. It contains 5 digits and it is also appended at the end of EAN13 barcode in order to encode detailed information about the book or the periodical including detailed date and author information. It is also used at point of sales system in order to encode information about the products being sold.

EAN5

Advantages

- EAN barcodes encodes only numeric digits which makes encoding and decoding algorithm simple and no lengthy user training is required to understand it.
- EAN barcodes are linear barcode and they can be easily encoded and decoded like most of the linear barcode.
- Automatic check digit provides security.
- EAN barcodes can be encoded and decoded by any average scanning barcode and no advanced barcode scanning device is required for this purpose.

Limitations

- Low data density; Similar to other linear barcodes, in order to store large data the width of the barcode has to be increased.
- Although encoding numeric only data brings simplicity yet it is not suitable if one wants to encode alphabets and special characters.
- The ability to tolerate damage is limited in EAN barcodes like other linear barcodes and barcode, once distorted or damage can be successfully decoded.

EAN2, EAN5 and EAN13 Collective Usage

As aforementioned, EAN2, EAN5 and EAN13 are collectively used for storing information about the books, and journals. Apart from them, they are used at checkouts and point of sale systems.

3.7 Codabar Barcode

Codabar barcode is a one dimensional barcode initially used for retail applications labeling. Codabar barcode can encode numeric digits from 0-9 and five characters including Plus (+), Minus (-), Forward slash (/), Colon (:), Dollar symbol ($) and Dot (.). Apart from numeric digits and the aforementioned character set, Codabar can also encode first four alphabets from 'a' to'd'; however, these alphabets can only be used as start and stop symbols. Codabar barcode is also known as, Code 2 of 7, ANSI/AIM BC3-1995, NW-7, Monarch, Rationalized Codabar, Ames Code or USD-4.

History

. In the year 1972, Pitney Bows Corporation developed a linear barcode which was named as Codabar barcode. Codabar was developed with intent to make it useful in the retail merchandise industry. Later on National Retail Merchant Association (NRMA) adopted another barcode standard in the year 1975; However Codabar did not lost its importance because people were now beginning to use it in medical, educational and shipping industry as well.

1234567890123

Purpose

In early 1970s, the need for a barcode standard was felt which could be printed with a simple dot-matrix printer and could be used on air bills of FedEx and also on blood-bank documents. It was for this purpose that work on a barcode standard started which could suffice these requirements.

Advantages

- Can be printed on simple dot-matrix printer.
- Codabar is an extremely barcode standard. It can be encoded and decoded by all types of printers ranging from simpler to complex ones.
- Simplest barcode standard, not much user training is required to understanding the encoding and decoding techniques.

Limitations

- Can encode only numeric digits from 0-9 and small set of characters and alphabets.
- It has very small fault tolerance for damages and distortion. It is not easy to recover data even if small portion of these barcodes is damaged.
- If large amount of data has to be stored, like other linear barcode types, its length has to be increased.

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Applications

- Extensively used in medical and surgical equipment owing to simple encoding and decoding technique.
- Used in shipping industry to recognize the parcels and shipments.
- Used in educational institutes and academic organizations.
- Codabar is used by several courier services in order to store information of the sender, receive and the item itself.

3.8 Interleaved 2 of 5 Barcode

Interleaved 2 of 5 barcode is a type of liner barcode which is encoded with numbers only. Interleaved 2 of 5 barcode encode numeric digits in pairs. For example the first bar will represent the odd number and the following space encodes the even number. As interleaved 2 of 5 encode data in the form of pair of numbers, it can only encode even number of digit. If user wants to encode odd number of numeric digits and white space is padded to the left of the barcode. It is a high density barcode but its length has to be increased in order to store large amounts of information.

History and Purpose

Interleaved 2 of 5 barcode is an evolved form of the simpler code 2 of 5 barcode. Interleaved 2 of 5 barcode have an added advantage over code 2 of 5 as it has shortened the length of the barcode by utilizing the white spaces between the barcode. Basic purpose of this barcode was to devise a compressed form of code 2 of 5 which could encode numeric numbers and can be easily encoded and decoded with simpler scanner.

1234567890123456

Advantages

- Interleaved 2 of 5 barcode is a linear barcode and like other linear barcodes it is easier to encode and decode data in such barcodes.
- Simple encoding mechanism, encodes numbers only. Can be scanned by any traditional scanner.
- Optional security mechanism through checksum digits.

Limitations

- Very limited fault tolerance as is the case with linear barcodes. Not easy to decode data once barcode is damaged or distorted.
- Can encode only numeric digits, that too in the form of pair which makes this barcode extremely monotonous in terms of encoding.

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