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.

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- 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.

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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

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

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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.

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- 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)1234567890123 1

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

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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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Usage

- Interleaved barcode is commonly used in warehousing industry.
- Some small stores and POS systems also employ this barcode standard for identifying store products.
- It is mostly used for small and simpler data encoding as complex data encoding requires variety of encoded characters.

3.9 Numly Barcode

Numly barcode is a type of linear barcode and is used to store information regarding the electronic products. It is based on code 39 symbology. Numly barcode is also known as ESN, Electronic Serial Number, ESBN and Electronic Serial Book Number. The length of the numly barcode is 19 digits.

Purpose

Numly barcode was developed with a purpose of uniquely identifying electronic items. Numly barcode is a unique number which is assigned to some electronic item in order to uniquely identify each electronic item. Particularly, PDFs, EBooks, Software, DVDs, Websites, emails and blogs are distinguished using Numly Barcode Symbology.

ESN 12345-678901-234567-89

Advantages

The advantages and limitations of numly barcode are same as that of any code 39 barcode symbology.

- Fast encoding and decoding because the data being encoded is only of the numeric type.
- No special scanning hardware is required and the barcode can be decoded using any simple scanner.
- Simple encoding and decoding algorithm makes it easier for a layman to understand and no extensive user training is required in this regard.

Limitations

- Low density barcode. As it can be seen from the image that in order to store large amount of data, the length of barcode has to be increased.
- Numeric only encoding. The barcode is not able to encode alphabets and special characters within its 19 digits.
- Extremely poor fault tolerance capability and damaged and distorted barcode cannot be decoded.

Usage

Primary user of numly barcode is the electronic and internet industry. It is used on software, websites, blogs, DVDs, books, PDFs and similar items in order to uniquely identify them.

3.10　　Optical Product Code

Optical product code barcode is a type of linear barcode used to encode numeric only data. OPC is based on interleaved 2 of 5 barcode symbology. Optical product code is also known as VCA, Vision Council of America barcode, VCA OPC, and OPC barcode. As UPC is used for identifying and marking general retail products, OPC is used for identifying retail optical products. Scanner enabled data entry services employ OPC code.

Structure

Optical Product code consists of a total of 10 characters. All the characters are numeric digits. These 10 digits are structured as follows:

- First 5 digits are assigned by the Optical product code council, Inc and they denote the manufacturer's information.
- The next four digits are specified by the optical code manufacturer and they contain the information about the item. These four digits must be unique for every item.
- The last digit is the checksum which is automatically generated.

1234567897

Advantages

- A very straight forward encoding and decoding technique, a layman user can understand it easily.
- Checksum digit provides automatic security feature.
- Based on interleaved 2 of 5 which mean that a simple scanner can be used to decode the information.

Limitations

- Can encode only numeric data. It cannot encode all the ASCII characters including alphabets and special characters.
- Limited density barcode. Can only encode small amount of data and in case large data has to be encoded. Width has to be increased.
- The ability to tolerate distortion and damages in optical product code is not very large.

Usage

- Widely used in warehouses and point of sale systems.

- Used at checkout points and small stores because of its simplicity and cheap scanning mechanism.

3.11 PZN (Pharma-Zentral-Barcode)

PZN barcode is a type of linear barcode and is a slightly modified version of code 39 barcode standards in a way that it can encode numbers only. PZN stands for Pharma zentral number or Pharma-Zentral-Number. It is also sometimes called Code PZN or CodePZN.

Structure and Variants

There are two variant of the PZN barcode standard, PZN-7 which is capable of encoding 6 or 7 digits and PZN-8 which is a more advanced version and can encode 7 or 8 digits. A special thing about PZN barcodes is that in these barcodes PZN is prefixed before the actual data being encoded. It is important to note that this PZN is generated automatically by the device and is not part of the barcode, it there just to reflect that this is a PZN barcode. A checksum digit is also appended at the end of the code based on the modulo 11 algorithm.

PZN - 1234562

Purpose

Germany pharmaceutical industry wanted to devise its own barcode standard in order to encode and decode information about the medical equipment and surgical tools. It is for this reason; PZN barcode standard was developed and widely used in pharmaceutical industry in Germany.

Advantages

- PZA barcode is a linear barcode standard and is extremely simple to encode and decode without any extensive training.
- Simple devices are enough to encode and decode information in these barcodes and no specialized hardware is required for this purpose.
- Numeric only encoding and decoding makes this barcode, extremely fast to encode and decode information.
- PZN barcode is secure because of checksum digit appended at the end of the code.

Limitations

- PZN barcode is a numeric only code. It cannot encode alphabets and special characters.
- PZN barcode is less dense as compared to the contemporary linear barcodes and it cannot store much information in small area.
- Being a linear barcode, the fault tolerance of PZN barcode is less and barcode, once distorted or destroyed is not easy to decode.

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Usage

As aforementioned, PZN barcode standard was developed specifically for German Pharmaceutical industry; there Pharmaceutical industry of Germany is making most of the use of PZN barcode in order to encode information about surgical tools and medical equipment.

3.12 Telepen barcode

Telepen barcode is a type of linear barcode which is used to encode all the 128 ASCII character. Telepen barcode improves and enhances 128 a barcode in a way that in Telepen barcode, all the 128 ASCII characters can be encoded without having to use a shift character in order to switch code. Another improvement in Telepen barcode is that now only two variations of barcode width are required in order to encode all the ASCII characters where as previously in case of code 128, a total of four width variations were required to encode complete ASCII character set.

ABCDEFGHIJKLMN

History & Purpose

Telepen barcode standard was developed by the Chairman of SB Electronics, George Sims in the year 1972. The basic purpose of developing Telepen barcode was developing a compact and highly secure linear barcode standard which could encode all the ASCII characters with minimum width variations and without using any shift operator. These were the basic requirements which no barcode could meet before the advent of Telepen barcode.

Advantages

- Numeric only mode of Telepen barcode can be double density.
- Telepen barcode can encode 16 digits or 8 ASII characters per inch which results in an extremely compact barcode.
- Fault tolerance up to 0.4x.
- Telepen barcode is extremely easy to print with fixed ratio of 3:1.
- Telepen barcode is extremely secure and there is a very little risk that the information is wrongly decoded.
- Telepen barcode is supported by almost all the leading barcode manufacturer as well as barcode encoding and decoding devices.

Limitations

Like other linear barcode, Telepen barcode lacks density and fault tolerance. Although with respect to linear barcode, it is quite dense and fault tolerant, yet it lags behind in these attributes when compared to 2-D barcodes.

Usage

- Telepen barcode is widely used in education sector of many countries, particularly in UK, Telepen barcode is used in public as well private libraries to keep record and information regarding books and other similar stuff.
- Telepen barcode standard is also being used in the automobile industry of the United Kingdom along with the ministry of defense.

3.13   UPC-A and UPC-E

UPC stands for Universal Product Code. It is type of linear barcodes and mostly widely used for retail applications.

There are two variations of UPC

- UPC-A
- UPC-E

UPC-A

UPC-A is a variation of UPC and uses 12 digits for information encoding. Out of these 12 digits, 11 digits contain the product information while the last digit is the checksum digit. The eleven product digits are further divided into three logical categories. The first digit represents the information regarding the type of the product. The next five digits contain information about the manufacturer of the product while the last 5 digits contain information about the specific product being encoded.

UPC-A

UPC-E

UPC-E is a shorter version of UPC-A. UPC-E contains 7 digits in total of which 6 digits contain the product information whereas the last digit is the checksum digit. UPC-E is also referred as "Zero Suppressed" version of UPC-A because it suppresses all trailing zeros in the manufacturer's information digits and all leading zeros from product information digits along with number system digit.

UPC-E

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History

UPC was designed by an IMB Engineer named George Laurer in 1971. IBM has originally asked him to base his barcode design on bull's eye pattern but he developed a barcode with pattern of vertical strips. With certain modifications and up-gradations, in 1974, the first UPC was pasted on a pack of Wrigley's gum which marked the paradigm shift in the way people use to shop.

Purpose

It is one of the oldest and most widely used barcodes. The purpose of developing UPC was to develop such a shopping or buying system where salesperson does not have to manually enter the information of a product in the database. This saves time and minimizes human error unlike manual information entry. For this purpose, IBM developed UPC in order to ensure, quick, easy and reliable information encoding for the retail products.

Advantages

- One of the oldest barcode types, extremely portable.
- Contains only numerals; simple and easy to encode and decode.
- Self-checking mechanism through checksum digit.

Limitations

- Only numeric data encoding/decoding. Can't encode characters and special characters.
- Little tolerance for damage. Cannot be decoded even if slightly damaged.
- Require close contact scanners to decode information.

Usage

- UPC-A is mostly used in USA, Australia, New Zealand, United Kingdom and Canada for encoding larger and simpler information.
- Used mostly in retail stores and small products. UPC-E is even shorter, and used mostly for food products.

Conclusion

UPC barcodes should be used in simple and retail stores product which do not require complex information encoding.

3.14   Patch Code

Patch codes are different from typical barcodes that have been explained earlier. Patch barcodes are basically codes consisting of 6 sets of distinct barcode patterns which are mostly used for document and file separation. Patterns used in patch barcode are referred as 1, 2,3,4,6 and T barcode patterns. These patterns are organized collectively to give an overall meaning and connotation to the patch barcode. These patterns are in the form of black and white bars which are

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arranged horizontally or vertically, running parallel to each other. Following are two of the six patterns used in Patch barcodes.

Pattern 3

Pattern T

History

Originally, patch codes were developed by Kodak. Patch codes were used to signal the data reading applications by sending commands to them. Application used to decode the signal of the patch code and process that accordingly.

Functionality

As aforementioned, patch codes are used for identifying desired document or milestones in bulk of documents. Following are some of the functionalities that patch codes perform in bulk of documents.

- They are used to signal the end of a particular document.
- Total number of pages in a document or total number of paragraphs.
- Used to calculate scan depth change.

Advantages

Patch codes possess all the advantages of a typical linear barcode. Some of the advantages are enlisted below.

- Simple and straight forward encoding and decoding techniques.
- No advanced user and employee training required understanding the barcode.
- Can be decoded and encoded using simple but expensive barcode devices.

Disadvantages

- Fault tolerance of patch code is limited as compared to other barcodes and code once destroyed or damaged cannot be decoded easily.

- Patch code has low density but it does not impact the overall performance of the code because its basic functioning is to mark and count end of documents and pages respectively.

General Instructions

Following are some of the instructions which must be followed for proper scanning of the patch code:

- Bars of the patch should be parallel to the leading edge of the document.
- The distance between patch code and any other printed information on the document should be at least 0.25 inches.
- A patch code of size 2.5 inches is considered standard. This size is ideal for scanning even if the barcode's position is slightly changed.
- Patch code's distance from the leading edge should not be greater than 3.75 inches.
- Codes should be printed with carbon based black ink.
- Patch code's material should be such that it should reflect less than 20% of the light.
- Patch code should never be printed on glossy paper.

Applications

Patch codes are used in all such domains where documents play a key role. Following are some of the application areas of patch codes:

- In libraries to store and mark books.
- In universities and educational institutions.
- Patch codes are widely used in banking and financial institutions where bulk of documents need to be scanned in shorter time.
- Insurance companies also employ patch codes to keep track of the insurance documents.

Conclusion

Patch codes are different from conventional barcodes in terms of its usage. All the barcodes are usually general purpose and have variety of applications whereas patch codes are limited to documentation industry.

4. Two Dimensional Barcodes

In section 3, several types of one dimensional barcodes were explained. In section 4 we are going to explain some of the most widely used two dimensional barcodes along with their history, pros and cons, usage and applications.

4.1 Data Matrix

Data Matrix is a type of 2-D barcode with very high data density and can encode large amount of data. Data Matrix consists of random sequence of black and white pairs. Data matric code type can encode text, as well as raw data. The range of the data encoded by Data matrix usually lies between few bytes up to 2 kilobytes. With this data storage space, approximately 2,335 alphanumeric characters can be encoded by a data matrix symbol. Data Matrix coding standard is widely used in Europe and United states for information encoding.

History

ID Matrix is credited as being the inventor of Data Matrix barcode around 2005. ID Matrix later on merged into RVSI Acuity ciMatrix, Siemens Energy and automation acquired RVSI Acuity ciMatrix in October 2005.

Purpose

Like other 2-D barcodes, basic purpose of developing Data Matrix code type was to design a barcode which is denser and can accommodate large amount of data, is extremely secure with built in error correction and higher fault tolerance mechanism. All of these objectives have been met by Data Matrix bar code.

Bytescout is encoded in this image

Advantages

- Similar to contemporary 2-D codes, Data Matrix can store large amount of data with minimum space utilization,
- It has built-in error correction mechanism. It uses ECC200 error correction code for error correction purposes.
- Extremely high fault tolerance and can be decoded even if substantial amount of code is damaged.

Limitations

There is only one major limitation of Data Matrix barcodes. Users have to have laser scanner or CCD cameras in order to correctly scan and encode information stored in these barcodes, it cannot be scanned by a simple scanner.

Usage

- Data matrix code is widely used in automotive part making industry as well as for laser marketing.

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- In aerospace equipment manufacturing industry, data matrix code is widely used on airplane parts. Air Transport Association (ATA) recommends the use of Data Matrix barcode to its members.
- Data Matrix is used on digital postage stamps recognized by Deutsche Postal Service.
- Mobile marketing has also adopted Data Matrix code and it is known as SemaCode in mobile applications.
- EIA (Electronics Institute of America), highly recommends the use of Data Matrix code in order to label small to medium sized electronics equipment.
- Data Matrix code are inscribed on medical and surgical equipment's.

Conclusion

Data Matrix codes are considered smallest and most compact of all the bar code types. If you want to store a large amount of data in a barcode, Data Matrix is the most recommended barcode type.

4.2 Maxi Code

Maxi code barcode is a type of two dimensional barcode used to store information about the postal and shipment packages in United States Parcel Services. It is a machine readable barcode standard developed by United Parcel Services and has public domain license. Although it is called barcode, it consists of large number of dots arranged in hexagonal grid pattern. Maxi code is also commonly known as Dense Code, UPS code, Target and Bird's Eye. ISO standard which supports maxi code is ISO/IEC 16023.
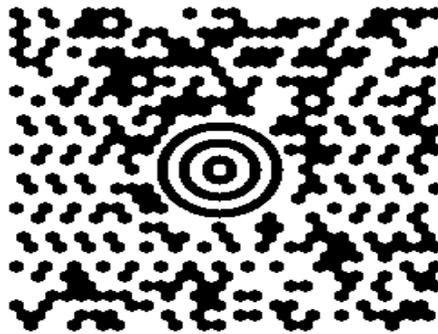
"ByteScout BarCode SDK for Software Developers", is encoded

Structure

Maxi code is a square of 1 inch which as a bull's eye in the middle of the code. Bull's eye is surrounded by a pattern of dots arranged in a hexagonal pattern. Maxi code is capable of storing both ASCII and extended ASCII characters. Maxi codes encode two messages; primary message and secondary message. Primary message contains information about the postal code, country code and the receiver's class information. Secondary message contains information regarding the actual address of the receiver; it can include other data as well.

History and Purpose

Maxi barcode was developed to store parcel and shipping information in United States Parcel services and was designed by the same organization in the year 1992.

Advantages

Maxi barcode is a two dimensional barcode and has a very high density, it can encode large amount of data in small area.

Maxi barcode can encode all the ASCII as well as extended ASCII characters, which is not possible in most of the linear barcodes.

Fault tolerance and damage recovery of Maxi barcode is very high, and distorted and damaged barcodes can be decoded with little effort.

Maxi barcode is extremely secure.

Limitations

Complex encoding and decoding algorithm which requires extensive user training to understand.

Cannot be decoded by simple linear scanning devices.

Usage

As aforementioned, United States Parcel Services are the biggest user of this barcode standard. This barcode is used to encode routing information regarding the shipments and parcels delivered across the country.

4.3 Aztec Barcode

Aztec Barcode is a high density, high capacity barcode. It is a type of 2-D barcodes. Aztec code is able to encode ASCII as well as Extended ASCII characters. Aztec barcode consist of black and white square modules like other 2-D barcodes. Aztec code can encode modules in the range from 15 x 15 to an upper limit of 151 to 151 modules. If Aztec code utilizes its maximum storage capacity of 151 x 151 modules it can encode 3000 characters and around 3750 numerical digits.

History

AIM, Inc, in 1997 published Aztec code for the first time. Andrew Longrace Jr and Robert Hussey are credited for having designed the initial barcode standard in 1995. The center of the Aztec code is similar in resemblance to the Aztec Pyramid. It is for this reason that this code has been named Aztec barcode.

Purpose

Aztec is a 2-D barcode. Like other 2-D barcodes, major purpose of developing Aztec code is to provide data encoding mechanism which could encode large amount of data in small area due to high density and which has substantial fault tolerance and error correction mechanism. Aztec code satisfies these requirements.

Bytescout123 is encoded in this Aztec code

Advantages

- Can encode all the 256 ASCII and extended ASCII characters.
- High density barcode can encode large amount of data in small barcode.
- As is the case with other 2-D barcodes. Aztec has extremely high damage tolerance capability; therefore a damage Aztec code can also be read unlike 1-D barcodes.
- Self-error checking and correction capability.

Limitations

- Cannot be scanned with simple scanning devices. Needs complex laser scanners.
- Requires substantial amount of training to understand. Not easy for a layman user to encode and decode Aztec code.

Usage

- Aztec code is used in travel and transport industry. Many transport companies such as Slovakian Railways, Czech Railways, Deutsche Bahm, Eurostar, KPK Intercity, Swiss Federal Railways, Virgin Trains, VR Group and Via Rails. These companies use Aztec code for the online ticketing which user can print.
- Airline companies have also adopted Aztec and this code is often inscribed on the board passes of the travellers.
- In Poland, registration documents of the vehicles have Aztec code inscribed on them which contains summary of the vehicle's information.
- Many company's in Canada use Aztec code on their invoices which contain the detail of the purchase and bill summary.

Conclusion

Best utilization of Aztec code is when one wants to encode extended ASCII characters because this is the code which allows the encoding of ASCII and all extended ASCII characters.

4.4 GS1 Datamatrix Barcode

GS1 Datamatrix is a type of 2-D barcodes. It is called GS1 Datamatrix due to the fact that this standard is specifically used by GS1 Systems. GS1 Datamatrix barcode is made up of several black and rectangle modules independently arranged in "L" shaped patterns. Basically, Datamatrix (ECC 200) barcode standard is formatted according to GS1 data format which results in the formation of GS1 Datamatrix.

History and Purpose

GS1 Datamatrix is an enhanced version of ECC 200 Datamatrix which was created by RVSI Acuity CiMatrix. Siemens Energy and Automation Inc, acquired this company later on. Datamatrix has immense advantages, it was for this reason GS1 system adopted the Datamatrix and added its own identifier in the data structure of the barcode and named it GS1 Datamatrix or EAN Datamatrix barcode. The purpose was to develop a robust and large capacity barcode with increased fault tolerance.

GS1 Datamatrix

Advantages

- Can contain large amount of data in small space like most of the other 2D barcodes due to high density.
- GS1 Datamatrix has a very large fault tolerance and data in the barcode can be decoded even if barcode is damaged.
- GS1 Datamatrix has built in error-checking capability which makes data encoding and decoding extremely secure.

Limitations

- It can be scanned only through camera scanners and ordinary scanner cannot be employed to decode the data. It is for this reason these barcodes are not often used at POS systems.
- Similar to other 2-D barcodes, GS1 barcode data decoding and encoding techniques are more complex and detailed user trainings are required to learn the encoding/decoding standards of these barcodes.

Usage

- GS1 Datamatrix is widely used in aerospace industry on the parts of the aerospace equipment.
- It is ubiquitously used in pharmaceutical industry to identify the surgical equipment and parts.

- US Department of defense is also using this barcode standard on their military and electronic equipment.
- Medical and health sector widely uses GS1 Datamatrix barcode owing to its large information storage capability.]

4.5 MICR E-13B

MICR E-13B is a standard font being used by American Bankers Association for automatic check processing in banking industry since 1995. MICR stands for Magnetic Ink Character Recognition font. MICR E-13B is the font standard based on E-13B symbology. MICR is widely acknowledged standard in USA, Canada, Australia, New Zealand and several other countries. MICR E-13B barcode consists of 9 numeric digits (0-9) and four special characters signifying Amount, Domestic, BSB and Dash.

History and Purpose

MICR font was developed in the early fifties when the banking sector was growing and it was not possible to efficiently and rapidly process bank checks. At that time, MICR worked in the principal of tape recorded. The bottom of the check contained the code which was scanned using headers which in turn transformed it into electronic signal hence the data in the check was decoded. A group of researchers from Stanford University and American Bankers Association started and developed MICR font with the purpose of improving banking transactions and check processing.
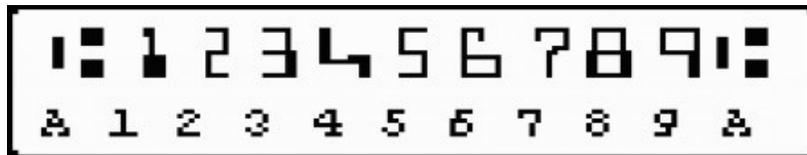
Advantages

First of its kind to encode and decode information about bank check and money order processing.

Extremely fast decoding; It is used in banking industry where fast transactions are required.

Simple encoding and decoding algorithm because it only encodes numeric data and four special characters.

Extremely secure, again this is need of the banking sector.

Limitations

Can only encode nine numeric digits and four special characters.

Limited fault tolerance and distorted image cannot be easily restored to its actual image.

Usage

Major user of MICR E-13B is the banking industry. MICR is used to process bank checks and money orders. In fact, many business corporations makes it mandatory that only checks with MICR font standard will be accepted. Countries which are widely using MICR E-13B in the banking industry are United States, Canada, Japan, Australia etc.

4.6 QR Code

QR code is an abbreviation for quick response code. It is a type of 2-D barcode (also known as matrix barcode). Unlike 1-d barcode, QR codes can encode wide variety of data types, including numeric, alphabets, special characters and binary data as well.

QR code consists of a set of square dots arranged in a square grid pattern with white back ground. The square dots are randomly arranged in order to encode information.

History

QR code was invented in 1994 by a Japanese automotive company named, Denso Wave. Denso Wave is a subsidiary of Toyota Motors.

Purpose

Purpose of QR code was to develop such an encoding/ decoding system which allows quick and reliable scanning of fast moving automotive equipment. In workshops, automotive parts are moved quickly from one place to another and are adjusted together. It is difficult to read such type of moving information with simpler barcodes; hence QR Code was developed to cater those needs.

Bytescout123

Advantages

- Can be scanned using a smartphone or any other phone with scanning capability.
- QR codes are versatile, the can encode almost all types of data e.g. numeric, alphabets, special and binary.
- Extremely fast scanning.
- Like other 2-d barcodes, QR code has good fault tolerance. Even if some part of the code is damaged, information can still be decoded from the code.
- Stores large amount of information unlike 1-d barcodes.

Limitations

- Smart phones used to scan QR codes are often expensive in comparison with simpler phones.

- Relatively new barcode type, people are not much familiar with its use. Requires training in order to fully understand the concept.
- Not very aesthetic, it contains random patterns of square boxes which might not look pleasing on products unlike 1-d barcodes.

Usage

- Used for document management, tracking products and time, inventory management, item identification and marketing purposes.
- Widely used in automotive companies in Japan.
- Business cards often contain QR codes inscribed on them which may contain related information to the websites or the links to the resume of a person.
- QR code enabled scavenger hunt was introduced by Starbucks for promotion purposes which contained information regarding the hints encoded in the QR code.
- Darling National Wildlife Refuge in Florida (USA) uses QR codes in trails which contain links to the detailed information regarding the animals.

Funny Fact: In Seattle, QR codes are inscribed on graves which contain link to the detailed information about the deceased person.

4.7 PDF417

PDF417 is a 2-d barcode type with high density and data encoding capability. It can encode huge amount large amount of data. PDF417 actually consists of set of linear codes stacked together to give a 2-d outlook. It is has been named PDF417 because it consists 4 bars along with white spaces, where each bar is 17 units long. PDF417 is also referred as Macro PDF, Macro PDF417 or the portable data file.

History

PDF 417 was developed in the year 1991 by a researcher named Dr. Ynjiun P. Wang at Symbol Technologies. Recently Symbol Technologies has been bought by Motorola.

Purpose

The basic purpose of PDF417 barcode type was to develop an encoding technique which could encode huge and complex data types. Before PDF417, most of the encoding techniques could only encode alpha numeric data along with some special characters, however there was a need of barcode which could encode large files, images and complex data, for this purpose PDF417 was developed which suffice the said requirement.

Advantages

- Can encode large variety of data types such as numeric, alphabets, binary, special characters. It can also store files including photographs, signatures, finger prints and several types of graphic formats.
- Can be scanned with handheld scanners as well as linear CCD scanners
- PDF417 is has extremely high density and can store large amounts of data like other 2-d barcodes.
- User can specify the length and width of the barcode unlike standard widths and lengths.
- No license is required to print this barcode format. It has Public Domain Format.
- Large damage tolerance like other 2-d barcodes.
- Built-in error detection mechanism

Limitations

- It is often larger in size as compared to other 2-d barcodes like QR code and datamatrix.
- It is extremely sensitive to the angle of the scanner and tilted scanner might not be able to decode correct information.

Usage

- PDF417 barcode type can be used to print postages which are recognized by the United States Postal Department.
- PDF417 is extensively used in transportation sector, particularly in the automotive industry like QR Code and other 2-d barcodes.
- Used in airline industry. PDF417 is inscribed on boarding passes.
- Inscribed on driving licenses and Real ID, issued by The Departments of Homeland Security.

Conclusion

In scenarios where we need to store complex data information in a barcode such as images and high graphic data, PDF417 is the best data format to use.

4.8 Codablock F Barcode

Codablock F barcode is a type of two dimensional barcode that belong to the Codablock family of barcodes. Codablock F barcode is basically a 2D version of code 128 barcode which was a linear barcode. Codablock F barcode improves and enhances code 128 in various aspects by introducing several advantages that comes with 2D barcodes and keeping simplicity of code 128 barcodes. Code 128 barcodes is designed in such a way that it can be divided and stacked in the form of multiple rows. Codablock F barcode can consist of 2 to 44 rows stacked over each other and each row can contain 61 data characters or 122 numeric characters.
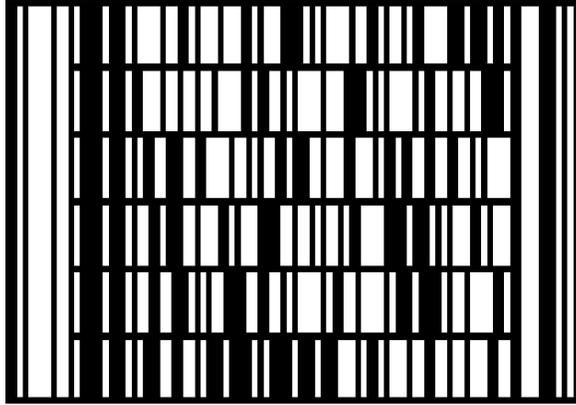
Source: http://commons.wikimedia.org/wiki/File:Codablock-F_Example.png

History

Codablock F barcode was developed in Germany in 1989 by Henry Oehlmann and Herald Oehlmann, the CEOs of ICS International at that time. Codablock F was developed to remove the deficiencies in code 128 and to store large amounts of data in smaller space which is possible with 2D barcodes.

Advantages

Codablock F barcode has all the advantages of a traditional 2D barcodes. Some of them are as follows:

- Codes of variable height, width and density can be used to store information which makes these barcodes extremely flexible and adapting.
- Codablock F barcode can be encoded and decoded using simple devices as internally code 128 algorithm is being used to encode the information.
- Checksum digit has been introduced to improve the security of Codablock F barcode.
- Block concatenation feature is also available in Codablock F through FNC2 technology.
- Numeric compression capability allows the compression of numbers and only 50% of the space is utilized for this purpose.
- High fault tolerance makes this barcode securer than the traditional code 128 barcode.

Limitations

There is one limitation in case of Codablock F barcode; these barcodes are not dense as compared to other 2D barcodes because actually they are a variation of 1D code 128 barcode.

Applications

Codablock F was standardized under AIM USS Europe - Codablock F standard and was widely used in the last decade of the 20th century. Following are some of the areas where Codablock F barcode is used.

- Medicine and health industry; where Codablock F barcode is used to label blood bottles, and surgical equipment.
- Retail stores where Codablock F is used to scan and identify retail sales item.

Conclusion:

Codablock F is a lightweight, 2D version of code 128 that couples simplicity of code 128 linear barcode and complex and advanced features of 2D barcodes.

4.9 Code 16k

Code 16k is another two dimensional barcode based on code 128 and Universal product symbology. Code 16k consists of stacked multiple rows of linear code, encoded using code 128 and UPC encoding algorithm. Like Codablock F, Code 16k also endeavours to improve and enhance capabilities of traditional Code 128 and UPC barcode by integrating two dimensional features in this barcode. Code 16k is capable of encoding all the 256, ASCII as well as extended ASCII characters. The minimum number of rows in code 16k is two while maximum rows can be 16. Code 16k barcode is has further three variations categorized on the basis of security algorithms they used.
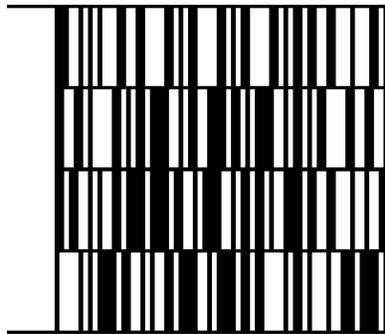
Source:

http://de.wikipedia.org/w/index.php?title=Datei:Code_16K_wikipedia.png&filetimestamp=2007052107
4816&

History

Code 16k barcode was developed in USA in 1988 by a scientist named Ted Williams while he was working for Laser Light Systems, a company that used to develop barcode encoding and decoding devices. Code 16k was developed with intent to add 2D functionalities to already existing linear code 28 and Universal Product Code.

Advantages

The advantages and functionalities of Code 16k are somewhat similar to those of Codablock F code.

- Each character has a parity bit that makes this barcode extremely secure and fault tolerant.
- Two checksum digits are appended at the end of the barcode in multiple rows, which further strengthens the security of overall barcode.
- A good thing about Code 16k barcode is that any conventional barcode reader is good enough to decode the information.
- Similar to Codablock F barcode, Numeric compression and block concatenation features are available in Code 16k barcode.
- Code 16k barcode is a high density barcode and can encode large amount of information in small space.

Limitations

Though, density and fault tolerance of Code 16k barcode is greater than all the linear barcodes, but it is still less than most of the generic two dimensional barcodes.

Usage

- Code 16k is mostly used in the USA and France in electronics industry for labeling of electronic circuit boards.
- Code 16k is also used in USA medical and health industry for labeling surgical and medical equipment.

5. 4 State & Postal Barcodes

4 State and Postal barcodes, as the name suggests are the barcodes that developed specifically for postal industry. These barcodes are pasted on shipments, parcels and mails and contain senders', receivers' and deliver point information. In this section, information regarding the most widely used and famous postal barcodes, have been compiled.

5.1 Deutsche Post Leitcode

INTRODUCTION

Deutsche Post Leitcode, also known as German Postal 2 of 5 Leitcode, Code Leitcode, Leitcode, Deutsche Post AG (DHL), implements Interleaved 2 of 5 barcode symbology. It is a type of linear barcode. The Leitcode is basically the address of destination or recipient and works as a router for mails and courier services in Germany. The encoded input is numeric consisting of digits from 0 to 9. The length is of fixed 14 digits which has the following structure:

5 digits (1 to 5) comprises of postal code,

Next 3 (6 to 8) digits consists of street ID(Number),

3 (9 to 11) digits after that represents house number and

2 (12 to 13) digits are for product code

The last digit (14) is the check digit

The check digit is added to avoid any scanning errors and to enhance security. It is calculated automatically through modulo 10 techniques.

00000.000.000.00

HISTORY

Deutsche Post AG developed Deutsche Post Leitcode for automated sorting of emails. It is used by Deutsche Post nowadays which is a brand of Deutsche Post AG in Germany. Deutsche Post AG is responsible for the assignment of a Sender number with accordance of the package volume.

Purpose:

As mentioned earlier Deutsche Post Leitcode was developed for the automated sorting of mails. In addition to that for 70 million mails to reach the destination each day requires both speed and accuracy that is provided by Deutsche Post Leitcode. These factors led to the development of Leitcode.

Advantages

- Since Leitcode are type of linear barcodes so they are easy to print.
- The scanning of Leitcode takes around 0.3 seconds which greatly improves the efficiency of the services.
- Leitcode space is perfectly ok for the addresses of the recipients. It takes small area in printing and hence no space is wasted.

Limitations

- Leicodes have fixed length of 14 digits which means only 10^{14} combinations of numbers can be stored.
- Due to small capacity of Leitcodes large amount of data has to be stored in the database which can be retrieved by scanning and then matching with the data stored in the database.
- The data type of Leitcodes is digital. If the address of the destination contains name of place etc. then this cannot be encoded. The inability to encode alphabets and other characters is a major drawback of Leitcode.

- It is easy to encode and decode data in Leitcodes but once they are damaged or poorly printed it's impossible to retrieve it to its original state. Even a small tear or an additional line can change the address of customer which can lead the package to wrong destination.

Usage:

Two major companies that make use of Leitcodes are:

Deutsche Post, which is the most widely used company in Germany for the domestic mail services, delivers around 70 million letters each day.

United States Postal Services (USPS).

The industries which make use of Deutsche Post Leitcode are:

- parcel shipments
- air cargo
- hospitals
- courier services
- shipping industry

5.2 Deutsche Identcode Barcode

Deutsche Identcode barcode is a type of linear barcode which is used to encode information about the mails and parcel items in German Postal services e.g. Deutsche Post AG and Deutsche Frachtpost. Deutsche Identcode barcode is a numeric only barcode based on interleaved 2 of 5 barcode standards but it cannot store alphabets and special characters.

Structure

Deutsche Identcode Barcode is 11 digits long with a 1 check sum digit. Total length of deutsche Identcode barcode is 12 digits which are divided into following segments.

- First 2 digits identify primary distribution center.
- Next 3 digits identify the customer.
- 6 digits identify the mailing address
- 1 last digit is the checksum which is optional.

00.000 000.000

Purpose

Basic purpose of developing deutsche Identcode barcode was to develop a barcode standard specifically for German Postal services which could encode and decode information about the mail and the customer.

Advantages

- Encoding and Decoding of deutsche Identcode barcode is quite quick because it contains numbers only.
- Encoding and decoding algorithms are very simple and no advanced user trainings are required.
- No special hardware and scanning devices are required to decode information. Simple scanner will decode all the information.
- Checksum digit ensures security of the encoded information.

Limitations

- Similar to other linear barcodes, damage tolerance capability of deutsche Identcode barcode is limited and distorted and damaged barcodes are not easily decoded.
- Deutsche Identcode barcode cannot encode special characters and alphabets; it can only encode numeric data.
- Data density of Deutsche Identcode barcode is less and it is not capable of storing large amounts of information in small space.

Usage

German Post is the major user of deutsche Identcode barcode. It is used for the routing of mails and parcels across Germany through encoded information. This encoded information can be the customer details, the parcel details and the source and destination of the mail.

5.3 KIX Barcode

KIX barcode symbology is a type of linear barcode standard based on famous 4 State barcode symbology. KIX Barcode symbology is capable of encoding numeric digits from 0-9 and alphabets from A-Z; however it cannot encode special characters. KIX Barcode symbology is commonly used in Royal Dutch TPG Post (Netherlands) in order to encode routing information about the mail or parcel. KIX Barcode is also commonly known as. Dutch KIX barcode, Klantenindex Barcode, Royal TNT Post Kix, Dutch KIX 4-State Barcode, Kix Barcode, TPG KIX , TPGPOST KIX.

Structure

KIX barcode is based on 4 state barcode symbology and consists of vertical bars of varying length in order to encode data. Each character is represented by a pattern of 4 bars. All the barcodes based on 4 state barcode symbology are somewhat similar in properties and structure. However difference between variants of 4 state barcodes lie in the checksum calculation algorithm which is

different for all the state 4 barcodes. KIX Barcode also has a unique t checksum calculation algorithm.

BYTESCOUT123

Advantages

Following are some of the advantages that KIX Barcode has over other barcode standards.

KIX Barcode utilized a very straight forward algorithm for encoding and decoding algorithm which is easier to understand.

No specialized and complex hardware scanners are required for decoding barcode information.

Security is provided thorough checksum digit which automatically ensures the integrity of data.

Limitations

KIX Barcode have a very limited barcode fault tolerance and if in case barcode image is damaged, it cannot successful decode the information.

KIX barcode, like other 4 state barcodes, cannot encode all the ASCII characters; they can only encode characters and numeric.

Data density of KIX barcode is very limited and in order to store large amount of data the width of the barcode has to be increased.

Usage

Primary user of KIX Barcode is the Netherlands (Dutch) postal services. Who use this code for routing mails across the country by encoding information such as the receivers address, the source and the delivery points etc.
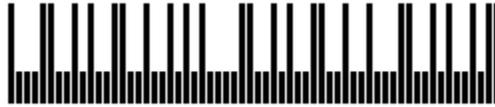
5.4 PostNET Barcode

PostNET barcode is type of numeric barcode which is used to store information about location in US postal service. PostNET stands for Postal Numeric Encoding Technique and is used to encode numeric ZIP codes.

History and Purpose

US postal service introduced 5 digit ZIP code in the year 1965 whose purpose was to categorize different geographical location of the country in a planned manner so that mail delivery system can be improved and more efficient. ZIP (Zoning Improvement Plan) was first introduced by Robert

Aurand Moon in 1940. PostNET barcode was developed in order to encode these ZIP codes on the postal packages.

Structure

PostNET barcode is represented using a series of bars and spacing varying in length. The variations in length and pattern contain information about the digit being encoded. The following table explains the digits and corresponding encoding pattern.

Value	Encoding
1	ⅰⅰⅰ‖
2	ⅰⅰⅼⅰ
3	ⅰⅰ‖ⅰ
4	ⅼⅰⅰⅼ
5	ⅼⅰⅼⅰ
6	ⅰ‖ⅰⅰ
7	ⅼⅰⅰⅰⅼ
8	ⅼⅰⅰⅼⅰ
9	ⅼⅰⅼⅰⅰ
0	‖ⅰⅰⅰ

Source:https://en.wikipedia.org/wiki/POSTNET

Advantages

- Simple and easy to read, with slight training and barcode symbols understanding, even a lay man can decode the numbers without having the need of any scanner or special device.
- A basic scanner is more than enough to encode and decode data in the barcode. No specialized hardware device is required.
- 2 Check digits ensure the security of the encoded information.

Limitations

- Can only encode numeric digits, although ZIP codes are in numeric form so this is not a limitation as such.

- Fault tolerance of these PostNET codes is extremely low, a slight damage or distortion can cause the package being delivered to wrong destination.
- Low density barcode, very less information in wide area.

Usage

PostNET barcode has been widely used in United States Postal Services department in order to encode ZIP code. However, this standard is now being replaced by one code solution which is officially known as intelligent mail barcode.

5.5 Royal Mail Barcode

Royal Mail barcode is a type of linear barcode which is used to encode postal information in United Kingdom Postal Services. Royal mail barcode is also known as customer barcode (CBC), UK Postcodes and RM4SCC (Royal Mail 4 State Customer Code). Royal mail barcode is capable of encoding numeric digits from 0-9 and the alphabetical characters from A-Z. Royal Mail barcode was developed between the years 1992-1994.

Structure

Royal mail barcode consists of a series of vertical barcodes. Each character is represented by four bars two of which are extended upward and the remaining two are extended downwards. The structure of Royal Mail Barcode is as follows.

- Start Character
- Encoded Postcode
- Suffix representing the delivery point (DPS)
- Checksum character for security
- Stop Character

BYTESCOUT12345

Purpose

Purpose of Royal Mail barcode was to develop a barcode standard specifically for UK Postal services, particularly the royal mail. This barcode standard can encode information about the mail or parcel being transferred and the destination address along with customer information.

Advantages

- Royal mail barcode has extremely fast encoding and decoding, very suitable for postal industry.

- Simple encoding/decoding algorithm, no specialized user training is required for this purpose.
- Checksum digit provides self-checking security mechanism.
- Royal mail barcode can be decoded by a simple scanner without any complex hardware.

Limitations

- Royal mail barcode can only encode numeric digits from 0-9 and alphabets from A-Z. It is not capable of encoding special characters.
- Damage and fault tolerance of royal mail barcode is not very high which can lead to inability to decode damaged and distorted barcodes.
- Royal mail barcode cannot store much information in small area which reflects low data density of this barcode.

Usage

Largest user of the Royal Mail barcode, as the name suggest and has been mentioned earlier is, UK Post and Royal Mail postal services who use this barcode on parcels and mails in order to store information related to the postcode and destination where the mail or parcel has to be routed.

5.6 Singapore 4 State Postal Barcode

Singapore 4 State Postal Barcode is a type of linear barcode with varying length of vertical bars, used to encode alphanumeric data in Singapore Postal Services commonly known as SingPost. This barcode symbology is based on 4 state barcode standard where each character is represented by four vertical bars having variable length. Singapore 4 State Postal barcode is capable of encoding numbers from 0-9 and the alphabets from A-Z. It cannot encode special characters.

History

British Post, the Royal mail developed 4 state barcode standard known as Royal Mail barcode in three years. Royal Mail Barcode was developed between 1992-1994. Based on the same 4 state barcode standard, Singapore post developed its own barcode standard in the year 1997. This barcode standard was almost similar to the Royal Mail Barcode with a difference in algorithm used to calculate checksum digit. This 4 state barcode standard was further followed by the Australian Post and the Canadian Post Corporation and they developed their own 4 state barcode standards in 1998. All of these 4 state barcodes standard are same. As mentioned earlier, the difference is only in the checksum digit calculation algorithm.

BYTESCOUT123456

Advantages

Advantages and limitations of Singapore 4 State Postal Barcodes are more or less same as the other 4 state barcodes such as Royal Mail Code. The advantages are as follow:

- The algorithm used to encode and decode information from the 4 state barcode is extremely simple and easy to understand hence time is not wasted on user trainings of such barcodes.
- Alphanumeric barcodes can be read very quickly, therefore 4 state barcodes are fast to read.
- Hardware devices and scanners, needed to decode information from these barcodes are very simple and cheap.
- Checksum digit automatically ensures that the security of the barcode is retained in case of 4 state barcode.

Limitations

- Low data density barcode, not capable of storing much information in small area.
- Once 4 state barcodes have been damaged or distorted they cannot be recovered and information cannot be decoded due to poor fault tolerance.
- Singapore 4 State Postal Barcode is not capable of encoding special characters and all the 128 ASCII characters cannot be encoded with this standard.

Usage

Singapore Postal Services namely SingPost is the largest user of this barcode standard, in fact it is designed keeping in view the requirements of the Singapore postal industry. With this barcode, routing information of the mail such as delivery points, destination and receiver's information is encoded in Singapore Postal services.

5.7 Swiss Post Parcel Barcodes

Swiss post parcel barcode is a type of linear barcode used in the postal service of Switzerland. It is also known as Swiss PostParcel Barcode or Switzerland Post Parcel Barcode. It is the standard barcode used by Switzerland Postal Services for efficient transferring of parcels around the country. The barcode identifies the information and destination of the receiver and ensures that parcel is being sent to the right person at the right location.

Structure

The total length of Swiss Post Parcel barcode is 18 digits. This is numeric only barcode and can only encode numbers from 0 to 9. These 18 digits are categorized as follows:

- Swiss Post reference consists of the first two digits.
- Franking licensing number contains the next 8 digits.
- The last 8 digits present the item number.

12.34.567890.12345678

Purpose

The purpose of Swiss Post Parcel barcode was to increase the efficiency and quality of the Switzerland's postal services and to improve the security of the parcels being transferred across the country. This barcode has somehow achieved its desired objectives and is now playing a significant role in the Switzerland postal department.

Advantages

- Simple encoding and decoding strategy, less user training is required to decode and encode data.
- Can be encoded by any simple device, similarly, can be decoded by simple scanning devices.
- Extremely fast encoding and decoding due to numeric only encoding.

Disadvantages

- Can only encode numeric only data, alphabets and special characters cannot be encoded.
- Fault tolerance of this barcode standard is low and distortion and damage may make it difficult to correctly decode the information.
- Low density barcode compared to Telepen and other similar barcode standards.

Usage

As aforementioned, and as the name suggests, the biggest user of Swiss Post Parcel Barcode is Swiss Postal service which is using it extensively for parcel and mail delivery services. However, some private courier and mailing services are also now adopting this barcode standard.

6. Conclusion

Barcodes are an efficient, reliable, robust and quick way of storing and retrieving useful information, particularly where large number of items needs to be associated with some sort of identification information. In this book, basic categories of barcodes have been explained along with myriad of information associated with each type of barcode. Readers can now read and decide what type of barcode is suitable for them according to their needs and area of business. While almost every area of business is computerized, barcodes can really leverage your business and decision making processes.

7. About ByteScout

ByteScout is the software company specializing in toolkits and components for software developers including barcode generation and barcode reading components, PDF manipulation, data extraction, video processing libraries. Toolkits are available for .NET, ASP.NET, JavaScript, Java. For more information and free evaluation versions download please visit WWW.BYTESCOUT.COM

7.1 Barcode Generator SDK

Barcode Generator SDK is the toolkit for software developers that contain a set of components to integrate barcodes generation functionality into desktop and web applications/sites.

- All the major linear and two dimensional barcodes can be generated (from Code 39, Code 128, EAN to QR Code, PDF417, Damatrix, Aztec, MaxiCode and others)
- Capable of directly adding barcodes intto PDF and TIFF documents;
- More than 100+ (and growing) ready to "copy-and-paste from" source code sample codes are included;
- Includes components for .NET, ASP.NET, WinForms, WPF, C# VB.NET, SSRS, Crystal Reports, Classic ASP, VB6, C++, Delphi, Excel VBA, Word VBA, MS Access and others;
- 12 months of technical support are included;
- And more.

More information on ByteScout Barcode Generator SDK and free evaluation copy is available here.

7.2 Barcode Reader SDK

Barcode Reader SDK is the toolkit for desktop and web software developers to integrate barcode reading for all major types of barcodes from images, photo files, PDF and TIFF documents

- Reads linear barcodes: Code 128, Code 39, EAN 13, UPCA, UPCE and more!
- Reads 2d barcodes: QR Code, Datamatrix, PDF417, Aztec, MaxiCode and others!
- Reads MICR font text from scanned bank checks and documents.
- Supports reading from JPG, PNG, BMP, multipage TIFF and PDF documents.
- Includes lot of source code samples for different programming languages.
- Can be used to read barcodes on a fly from web camera (source code sample demo included)
- Provides noise and image corrections functions.
- 12 months of technical support are included.
- And more!

More information on ByteScout Barcode Reader SDK and free evaluation copy is available here.

7.3 Other ByteScout's tools for developers

Following is the list of other developer tools by ByteScout. Click on the names of the product to see more details.

- Bytescout PDF Generator SDK for JavaScript - generates PDF files from client-side JavaScript
- PDF Renderer SDK - converts PDF documents into images with no other tools or libraries requires
- PDF To HTML SDK - converts PDF documents into HTML documents with text, images, graphics etc.
- Bytescout PDF Viewer SDK - ready to use winForms control to view PDF documents inside your desktop applications
- Image To Video SDK - generates video slideshow with sound from images with 2D and 3D effects
- Spreadsheet SDK - read and write XLS, XLSX files in .NET, ASP.NET with no Excel required
- Bytescout Bitmap Visualizer for Visual Studio 2005/2008/2010/2012 - free plugin to preview bitmaps in Visual Studio debugger
- Bytescout PDF Extractor SDK - extracts text from PDF, information about PDF document, extracts data from tables in PDF into CSV and XML
- Bytescout Screen Capturing SDK - records screen from your application into video with sound, mouse pointers and more
- Bytescout SWF To Video SDK - converts SWF flash files into video files
- Bytescout Watermarking SDK - adds watermarks to pictures and images from your desktop and web applications

For more information and free evaluation version of these and other toolkits for developers please visit www.bytescout.com