

## All About 2D Bar Codes

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YOU MAY NOT KNOW what they are, but chances are, you come across them on a regular basis — on your cell phone bill, airline boarding pass, and parcels delivered to your home. They're 2D (two-dimensional) bar codes, an advanced type of bar code that can pack loads of information into a very small space, sometimes even in an area as tiny as a pin-head.

When most people think of bar codes, they think of 1D bar codes, which consist of a row of parallel vertical lines. This is the type of bar code that you will find on most retail packaging. Conversely, 2D bar codes can appear in a variety of configurations, such as a block of multiple 1D bar codes stuck on top of each other, or a swarm of dots with a bull's-eye in the middle.



### 1D vs. 2D Bar Codes

A good way to think about 1D bar codes is as a printed version of the Morse code. Instead of dashes and dots, a 1D bar code uses wide bars and narrow bars to encode information. What a bar code scanner does is analyze the wide bars, narrow bars, and spaces in between to extract the original information.

First used in retail in the 1970s, 1D bar codes have the drawback of not being very space-efficient: they get longer as more data is encoded. As a result, 2D bar codes were invented in the late 1980s as a way to encode more data into a smaller space. While 1D bar codes encode data in only one dimension (horizontally), 2D bar codes encode data in two dimensions (horizontally and vertically), enabling them to compress more information into a smaller space. This is why 1D bar codes are also known as "linear bar codes", and 2D bar codes are also called "area bar codes".

Today, 2D bar codes are so advanced, that while a 1D bar code can only encode a number or string of characters to enter into a database, a 2D bar code can actually hold the entire database. For example, you can embed an Excel spreadsheet into a 2D bar code, to use as a portable database. Most 2D symbologies (bar code lan-

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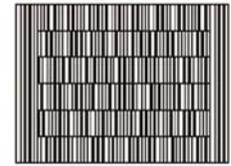
guages) can hold at least 2,000 characters per bar code. The typical 1D bar code contains about 30 characters.

### Types of 2D Bar Codes

There are two main types of 2D bar codes, which use different strategies for condensing information. They are known as 2D stacked and 2D matrix.

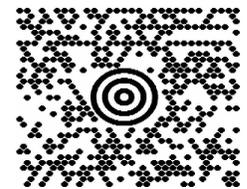
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The first 2D bar code was invented when Dr. David Allais of Intermec decided that, instead of having one really long bar code to encode a lot of data, it would be better to chop the long bar code into different segments and stack them on top of each other, forming one symbol. This is essentially how all 2D stacked bar codes are designed. While linear bar codes can be read with a wide range of scanning technologies, 2D stacked bar codes are more sophisticated, and can only be decoded with CCD (Charge Coupled Device), laser or image-based readers, as well as with any camera that can produce an electronic image (e.g., a camera phone). Examples of 2D stacked symbologies include Code 49, Codablock, PDF417, and some versions of GS1 DataBar (formerly known as RSS (Reduced Size Symbology)).



*Codablock bar code*

Instead of a stack of linear bar codes, 2D matrix bar codes consist of an array of data cells. The data cells can be squares, forming a checkerboard-like grid, or a variety of other shapes, like circles, hexagons or other polygons, connected in a pattern. Many matrix bar codes have a bull's-eye or other target pattern(s) so bar code scanners know which direction to read the code. As a result, unlike linear or 2D stacked bar codes, 2D matrix bar codes can be scanned from any direction.



*Maxicode bar code*

2D matrix bar codes can pack much more data per unit area than linear or stacked symbols. Today, they are even being laser-etched into diamonds and other gemstones to record their pedigree. However, 2D matrix symbols also require more advanced printing and reading equipment. They can only be read with image-based scanners, which like a camera, take a picture of a bar code for decoding. For example, the Socket Mobile CompactFlash Scan Card 5X uses image-based scanning technology and can read 1D, 2D stacked, and 2D matrix symbologies.

All 2D matrix symbols have error detection and correction features, making them more robust for use in industrial production processes and harsh operating environments. Many can even be read if part of the code is damaged, covered or distorted. Examples of 2D Matrix symbologies include Data Matrix, MaxiCode, QR Code (Quick Response Code), and Aztec Code.

### 2D Bar Code Applications

Today, 2D bar codes are utilized in a variety of industries. Manufacturers use them to track both parts and finished products as they travel through the supply chain. The United States Postal Service, Deutsche Post, Japan Post, and other postal agencies use 2D bar codes for applications like sorting letters and parcels, tracking certified mail, and processing sales. Transportation firms use them for automated package tracking, bills of lading, and consignment notes.

Government agencies use 2D bar codes for ID cards, registrations, and asset tracking. For example, driver's licenses in many states have a PDF417 bar code containing not only a person's name, address, and other text information, but also image files of his/her photo, fingerprints and biometric data.

In the healthcare industry, PDF417 and Data Matrix are commonly used on patient ID bracelets, medications, and insurance forms. For example, many hospitals print 2D bar codes on both patient wristbands and medications, so nurses can quickly scan them to verify patient identity, drug type and dosage before giving medicine to patients.



Many pharmaceutical and biomedical companies use Data Matrix bar codes to track laboratory samples, and retailers use GS1 DataBar bar codes for processing sales, managing returned goods, and controlling inventory.

### Choosing Between 1D and 2D Bar Codes

When deciding whether to implement 1D or 2D bar codes in your organization, if your industry hasn't already standardized on a symbology, there are many factors to consider — the type of data to be encoded, amount of data, type of printing equipment available, and type of scanning environment, just to name a few.

Linear bar codes are ideal if space is not an issue and messages are short, because linear symbologies are common around the world and easy to print. Linear bar code scanners are also less expensive and easier to find than 2D scanning devices.

2D bar codes are best if space is very limited, lots of data must be encoded, and/or the data has complex characters (e.g., Chinese or Japanese). Although 2D bar codes are more expensive to deploy than 1D bar codes, they are still cheaper than RFID technology. From a cost point of view, it often makes sense to combine 2D bar codes with 1D and/or RFID technologies.

### Market on the Upswing

You can expect to see more and more 2D bar codes in the future. Research firm Frost & Sullivan estimates that the market for 2D bar code scanners in North America will grow 14.5 percent in the next few years, compared to only 5.7 percent for 1D bar code scanners. The market for 2D bar code scanning is still in an early growth stage, while the 1D scanning market is reaching a stage of early maturity.

Significant growth in 2D bar code scanning is expected in the government and pharmaceutical markets. Government agencies such as the Department of Defense are beginning to standardize 2D bar codes with suppliers. Based on mandates from the Food and Drug Administration (FDA), pharmaceutical companies are deploying 2D bar codes to better trace drugs in case they need to be recalled.

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