Fundamentals of PDF-417 Symbology

*The Microscan MS-850 and MS-880 scanners read PDF-417 **and** standard linear codes.*

The advent of PDF-417, a 2D stacked linear code, brought two important changes to the bar code industry. Firstly, it provided a method of greatly increasing data capacity in a label. Secondly, through built-in error correction, it provided a way to ensure that the added information could be accurately decoded.

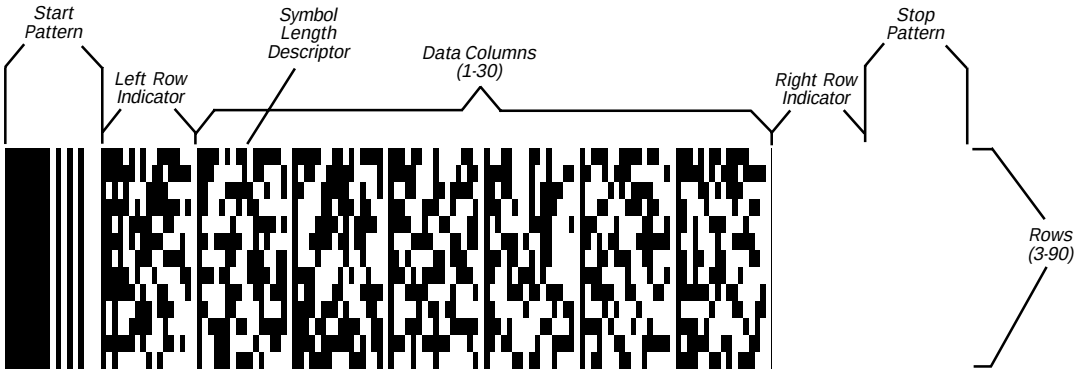
"PDF" stands for portable data file, aptly named as the symbology can hold (in a reasonable amount of space) a maximum of 1850 ASCII characters and 2710 numeric digits, enough to encode an entire database. This far exceeds the data capacity of any linear code. Because of this limitation, linear codes force the user to rely on external database lookups to provide complete information on the stored data. Conversely, PDF-417 provides the ability to carry all of the information with the code, particularly beneficial to open systems.

By stacking linear codes, PDF-417 provides increased data capacity.

This PDF-417 label has 250 alphanumeric characters.

Symbology Structure

PDF-417 uses a technique that stacks multiple linear rows together which dramatically increases the amount of data that can be encoded compared to linear symbologies. Every PDF-417 label has distinct elements, including start/stop patterns, left/right row indicators, data columns, and rows. PDF-417 can be scanned by linear scanners, rastering laser scanners, or two-dimensional imaging devices.



The Importance of Reed-Solomon Error Correction

Using Reed-Solomon error correction, up to 50 percent of the label can be damaged or torn while still maintaining readability.

The user selects the degree of error correction for the label at the time the label is created. Levels range from level 0 to level 8, with level 8 being the most redundant.

Error correction identifies two types of errors, 1.) rejection errors, called "erasures," and 2.) substitution errors, called "errors." An **erasure** is a missing, unscanned or undecodable symbol character where the position of the symbol character is known but not its value. An **error** is a misdecoded or mislocated symbol character where both the position and value of the symbol character is unknown.

Readable code (level 6 error correction)

Readable code (level 6 error correction)

Erasure error example

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The table at right shows the minimum recommended error correction level for open systems using numeric and alphanumeric characters.

Note that a symbol's size will increase with the level of protection, as illustrated with the PDF-417 symbols below. While the information in these symbols is identical, their sizes vary dramatically depending on the error correction level (ECL) that was used.

Minimum Error Correction Level	Numeric Characters	Alphanumeric Characters
2	1 to 80	120
3	81 to 480	320
4	481 to 960	640
5	961 to 2580	1720
6	2581 to 2710	1721 to 1850

Code Information:
Encoded data = Microscan MS-850
X-Dimension = 10 mil
Row height = 3X (30 mil)


ECL 0

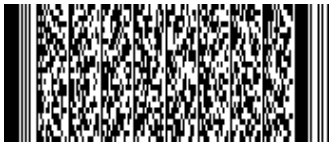

ECL 1

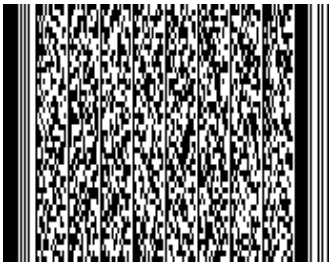

ECL 2

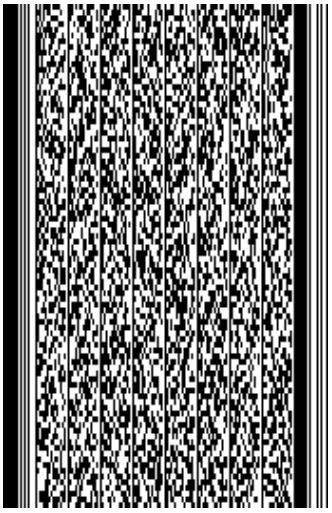

ECL 3


ECL 4


ECL 5


ECL 6

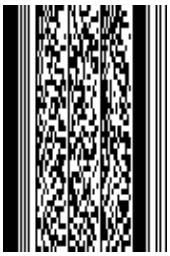

ECL 7


ECL 8

PDF-417's Versatile Use of Aspect Ratio

Aspect ratio is the proportion of the width of the label to its height. As shown in the examples at right, a PDF-417 symbol's aspect ratio can be varied to suit real estate requirements without changing the information in the symbol. This is possible because PDF-417 specifications allow the user to specify the number of rows or columns when printing.

Data Columns = 1



Data Columns = 8

Code Information:
Encoded data = Microscan's MS-850 reads PDF417 with any error correction level
ECL = 0
X-Dimension = 10 mil
Row height = 3X (30 mil)

Tilt Versus Code Density

Because every three rows of a PDF-417 label has its own encoding scheme, to successfully read a PDF-417 label the tilt of the laser beam cannot cross more than three rows. Notice that in examples B and C the tilt is unchanged. However, because the label in example C consists of shorter row heights, its readable zone is correspondingly smaller.