



ExpoTools 1D Barcode Encoding Guide

Overview

This document outlines some basic guidelines for 1D barcodes and also provides configuration codes that will optimize ExpoTools scanners for use with 1D barcodes. Note that this information is provided only as a starting point for creating 1D barcodes suitable for use with ExpoTools scanners. It is the responsibility of the customer to ensure that the chosen barcode, layout and resulting printout is suitable for the intended purposes.

1D Symbologies

One dimensional barcodes (or linear barcodes, as they are sometimes called) consist of a series of vertical black and white stripes. They differ in appearance from two dimensional barcodes, which look more like a scattered collection of dots. Certain sequences of stripes correspond to a given character or number. There are a staggering number of systems that encode characters or numbers as different patterns of stripes, and each of these systems is referred to as a symbology. There are literally several hundred different barcode symbologies currently in use, and the ExpoTools line of barcode scanners can decode most of them. The most common 1D symbologies used in the events industry are Code 39 and Code 128. These two symbologies are usually better choices than others, but offer some tradeoffs between them.

Ease of Scanning

1D barcodes are visually simpler and computationally less complex than 2D barcodes. They are easier to get into focus and quicker to decode. This makes them much faster to scan in situations where there are a large number of people, such as door scanning or room attendance applications.

Error Correction

1D barcodes are simpler to print and contain far less information than 2D barcodes, but oddly can be less tolerant of damage or printing defects. This is due to the lack of redundant encoding and error correction codes in most 1D symbologies. Joining two stripes, or erasing one altogether, will usually make it impossible to decode a 1D barcode. The same defect in a 2D barcode will often not make it un-decodable thanks to the extra information these barcodes contain. Fortunately, a certain amount of redundancy can be included in a 1D barcode by making it taller. This makes it less likely that the barcode will have a problem, but note that vertical printing defects, which are common with wax printers, will almost always cause problems.

Mis-Scans

One of the most problematic issues when using 1D barcodes is that they can be misread more easily than 2D barcodes. This is somewhat counter-intuitive, but derives directly from the complete lack of error correction in 1D barcodes. It is possible for a 1D barcode

to be read as another code depending upon reflections, lighting or orientation. Although not frequent, this type of error can be expected somewhere on the order of one scan per ten thousand. In cases where safety or accountability is an issue, 2D barcodes are usually a more suitable choice.

Code 39

Code 39 (also sometimes referred to as ‘Code 3 of 9’) is an excellent choice for badging for several reasons. First, it contains a simple error checking mechanism wherein if one barcode stripe is removed or blurred into a neighboring stripe, the barcode will not decode at all. This is important; with some systems, damage to a single stripe will go undetected and cause the barcode to decode to a different number altogether. It is far better to know that a code has been damaged than to decode it incorrectly.

The second advantage of the Code 39 symbology is that it can be printed simply by using a special font. This is not the case for some other barcode symbologies. This is possible because Code 39 uniquely maps one character to a given pattern of stripes. No knowledge is required of what came before that character, or of what will come next, to generate the stripe pattern. It is a straightforward substitution: the shape of a letter to a pattern of stripes.

Code 39 Problems

While a very suitable symbology for most applications, Code 39 has a few drawbacks. The first is related to the way that it always encodes a character as the same set of stripes. This makes for longer barcodes since it does not take advantage of a form of compression possible when the preceding characters are taken into account. Code 39 barcodes are longer than they would be in some other symbologies.

Another problem is that Code 39 requires a start and end character (both are an asterisk, i.e. ‘*’). This adds two characters to the length of the barcode. This also poses a problem when printed using a simple font substitution, as some fonts will automatically add the leading and trailing asterisks, while some will not. This is a common problem when the barcodes are printed directly by the customer using general purpose software, such as MS Word or Crystal Reports.

Finally, while Code 39 can readily handle characters and numbers, it does not handle symbols (such as ‘\$’ or ‘@’) or lower case characters well. Support for these was added later and is not really part of Code 39, but rather Code 39 Extended. To encode these symbols, Code 39 Extended adds a plus character (i.e. ‘+’) immediately before the usual Code 39 symbol. This has the effect of doubling the size of the barcode. For example, the barcode for ‘test’ would be double the size of the barcode for ‘TEST’ since it would actually contain ‘+T+E+S+T’.

Code 128

Another excellent symbology is Code 128. This code differs from Code 39 in that it does not always represent a given character with the same set of stripes. Instead it creates the stripes for a character based on the stripes generated for previous characters. You can

think of it as encoding the difference between the current character and the previous one instead of the character itself (this is an oversimplification, but illustrates the point). This approach requires less information because it ‘builds’ upon the previous encoding. Code 128 barcodes are therefore smaller than their Code 39 equivalents (by about thirty percent, although this varies with the content of the barcode). It also uses several stripe thicknesses, thereby further increasing its density.

The disadvantage of Code 128 is that it cannot simply be printed using a font as it needs more than a simple character-to-stripe lookup table. Special software is usually required that will generate the correct sequence of stripes based upon the information to be encoded. As such it is difficult for novices to generate.

S 2 of 5 and Code 11

Special mention should be made of a specific symbology called S 2 of 5 (aka ‘S25’ or ‘iS25’). This barcode was developed for labeling boxes in the manufacturing industry. Although it has the advantage of being very compact, it is unsuitable for badging and identification applications because it lacks any error detection mechanism. An S25 barcode will decode differently depending upon the angle at which it is read. The shipping industry eventually added a rectangular bounding box to S25 in order to reduce the problem, but it remains an execrable choice for most applications.

Another equally unsuitable symbology for most applications is Code 11 (aka ‘Code Eleven’ or ‘Code 1 of 1’). This symbology contains a check-digit that is extremely difficult to compute because it can be done in a number of ways, each of which is mutually exclusive. In order to decode it, you need to know which check digit approach was employed (and hope that it was computed correctly). While this can be done, it makes setup more difficult and provides an additional place in which difficulties can introduce themselves.

Parameters and Terms

A 1D barcode is easier to specify than a 2D one. There are only 4 basic parameters:

- The size of the smallest stripe in the barcode, known as an *element*
- The *ratio* between the thinnest stripe and the thickest one
- The *height* of the stripes
- The amount of whitespace before and after the barcode, known as the *quiet zone*.

Note that there is no error correction level specified, which there would be for most 2D barcodes. From these basic parameters, and the data to be encoded, the length of the barcode is derived.

Capacity

Although ExpoTools barcode scanners can read up to 480 characters from a badge, 1D barcodes are not designed to encode that much data. The typical payload is around 5 characters, with a maximum of about 15. Note that Code 39 and Code 128 symbologies can encode both letters and numbers without any problems. For larger payloads you will need to use 2D symbologies, such as PDF417, Datamatrix or Aztec.

Guidelines for use with ExpoTools Scanners

When printing 1D barcodes, you should keep the following *minimum* requirements in mind:

- a minimum element thickness to fifteen thousandths of an inch (0.015")
- a minimum thick to thin ratio at 2.0
- a minimum barcode height of 0.25"
- a quiet zone of at least 0.15" before *and* after the barcode.

These are absolute minimums; larger element sizes, ratios and heights will lead to a better barcode, both from an ease of scanning and a reliability standpoint. The only downside is that the barcode becomes somewhat larger, but the increase is not substantial.

The *recommended* values for use with ExpoTools scanners are **0.015" element size, 0.35" height, a thick-thin ratio of 2.5 and 0.25" of quiet zone** before and after. Thick thin ratios of more than 3 should not be used as they offer no advantages. Although the height of the barcode is less critical, increasing it to 0.35" will make it less susceptible to printing defects and dropout. A height of more than half an inch should be avoided as it once again offers no real advantage and becomes aesthetically awkward.

These settings provide a good balance between area and ease of scanning for the user. Other configurations will work, but may prove more difficult for the untrained operator to scan.

The most common problems related to 1D barcodes are blurring between the vertical stripes (i.e. the elements). The key to avoiding this problem is to keep the minimum element size substantial. This will reduce the bleed over from dark stripes into the white bands. A common mistake is to reduce the element size when trying to reduce the overall size of a barcode. It is better to keep the element size relatively big, but to reduce the ratio of thin to thick stripes from, say, 3.0 to 2.5 or 2.0. Code 128 barcode generating programs do not usually allow the thick-thin ratio to be altered, but if such a setting exists in your software, set the ratio to 2.5.

The Badge Holder

Whatever badge design you arrive at, you must test the resulting barcode inside the badge holder that will be used at the show. Two problems arise. The first is that the reflective surface of the badge holder makes the barcodes harder to scan. Holding the scanner at a slight angle helps alleviate this, but a code that scans on plain paper will always become more difficult to scan once in the badge holder. The second problem is that many shows use badge holders with opaque or coloured stripes. If these overlay the barcode, they can make it impossible to decode.

Placement

As always, be careful not to place the barcode too close to the edge of the badge, as paper misalignment can cause part of the code to print beyond the perforation. This can make the code unreadable, and the lack of error correction codes makes this more of a concern than for 2D barcodes. Also beware of the aforementioned colour stripes.

When using 1D barcodes alongside 2D barcodes, it is best to keep them separated so that the operator can readily scan the code he wants to. In situations where they are adjacent to each other, all ExpoTools scanners can be set to only decode a given symbology, although it is usually a less desirable solution than properly designing the badge layout.

Testing

When testing the badge design, be aware that most users will not have the same familiarity with the equipment you do. As such, what is easy for you to scan may prove difficult for a new user, since they have little or no understanding of how to position the scanner. Also make sure when testing that you are using a badge with the maximum number of characters that will be encoded. Test badges often contain only small amounts of data, and this makes them easier to scan, but they are not representative. You should also avoid any settings that would automatically change the parameters of the encoding to suit a larger amount of data, as these can lead to barcodes that have been compressed to the point of illegibility.

When using special media, such as when printing onto plastic card or when using glossy card stock, you will need to adjust these settings. PVC or credit-card type stock is especially bad because of the increased likelihood of substantial printing defects and its reflectivity.

Using 1D Barcodes in Conjunction with ShowMaster

If you are using ExpoTools ShowMaster software to manage the equipment, data and customers, there is an additional benefit to adding a 1D barcode to your badge, and for placing it some distance from any 2D barcode you may also be using. ShowMaster is able to dynamically regenerate or fill in the badge data from a registration database as the equipment is returned. This happens instantaneously and transparently as the scanner is checked back in. It is a great way to ensure the accuracy of the scans, since missing fields, additional data or any changes to the attendee information badges made during the show can be added in at the end of the show. However, the addition of a 1D barcode can also provide a simple fail-safe for when the main 2D barcode is damaged, misprinted, obscured or for when an exhibitor just can't get it to scan.

In these cases, you can instruct the exhibitor to scan the 2D barcode since it is preferable, but if there is any difficulty they can just fallback to the 1D code. They won't see the data on-screen, but it will get filled in when the data is pulled out by ShowMaster.

In order for this to work, you will need to leave the scanners enabled for both 1D and 2D barcodes, so you should position the 1D barcode in such a manner as to minimize the likelihood that the operator will inadvertently scan the wrong one. The 1D barcode must contain the ID number that uniquely identifies the attendee, and that same number must be present in the first characters of the 2D barcode (field 1). You will also need that field present in the registration database. This is the same database that you will need to link using the ShowMaster 'Database matchup' function.

Sample Barcodes

Below are a number of sample barcodes with different element sizes and ratios that illustrate the effect of different settings. All are 0.25 inches tall, slightly smaller than the recommended value. The last two Code 39 samples are especially interesting: a barcode with .015 wide elements and a ratio of 2 actually takes up less space than the same code with 0.010" wide elements and a ratio of 2.5. The 0.015 version will however be more tolerant of printing defects and be easier to scan.

Code 39, 5 digits, 0.015" 2.0 ratio



Code 39, 5 digits, 0.015" 2.5 ratio



Code 39, 5 digits, 0.015" 3.0 ratio



Code 39, 10 characters, 0.015" 2.0 ratio



Code 128, 5 digits, 0.015" (2.5 ratio)



Code 128, 10 digits, 0.015" (2.5 ratio)



Code 39, 10 characters, 0.015" 2.0 ratio
(showing effect of lowercase data)



Configuring ExpoTools Scanners for 1D Operation

By default, ExpoTools scanners ship able to read PDF417, Code39 and Aztec symbologies. In situations where they will be used for attendance or door tracking, they can be configured to decode 1D barcodes only. This will keep the operator from scanning the 2D barcode (if present) on the badge, possibly speed up the scanning and make it easier. It is usually only a requirement if the software later used to download the information is likely to be confused by the presence of both 1D and 2D data.

ExpoTools software can be used to automatically select the correct symbologies on handout. However, if you are not using ExpoTools software, you can follow the manual procedure show below. This approach is not recommended as it can result in handling errors.

To manually configure a scanner for just 1D scanning, scan the first barcode for 2 seconds, then immediately scan the second one for 2 seconds and then move to the last one. If successful, the scanner will show ‘OPT. 1D’.



Step 1: Linear Opt. Mode (scan for 2 seconds)



Step 2: Disable PDF417 (scan for 2 seconds)



Step 3: 1D Confirmation barcode

Restoring 2D (Normal) Configuration

To return a scanner to a basic configuration (Code 39 and PDF417), scan the first barcode for 2 seconds, then immediately move to the next one for 2 more seconds and finally scan the rectangular one. If successful, the scanner will show 'Set to Code 39 / 128 / PDF417 / Aztec' on the display.

Step 1: 2D Restore (scan for 2 seconds)



Step 2: Reconf. Barcode (scan for 2 seconds)



Step 3: Reset Confirmation barcode

