



# ALL ABOUT BAR CODES



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## INTRODUCTION

In today's business environment, staying competitive is critical to your success. Bar code data-collection technology is an effective way to improve the bottom line and meet the competitive challenges your organization faces every day.

This special guide from PSC Inc. is designed to give you and your company information about bar code data-capture technology.

Combined with data-collection technology, bar codes provide a rapid, accurate, and efficient means to collect, process, transmit, record, and manage data in a variety of industries. Retail, package delivery, warehousing and distribution, manufacturing, health care, and point-of-sale applications can all benefit from the use of bar codes.

Whatever the application, whatever the environment, PSC puts all its efforts into making our bar code based data-collection products perform in the real world. Please call us today at **800-695-5700** for more information and the name of a reseller in your area who can work with you as you plan your bar code based solution.

## ABOUT BAR CODES

A bar code can best be described as an “optical Morse code.” Series of black bars and white spaces of varying widths are printed on labels to uniquely identify items. The bar code labels are read with a scanner, which measures reflected light and interprets the code into numbers and letters that are passed on to a computer.

*Figure 1:* A typical bar code (Code 39)



## AUTOMATIC IDENTIFICATION

Automatic identification or "Auto ID", encompasses the automatic recognition and recording of data, most commonly through the printing and reading of information encoded in bar codes. Bar codes allow for rapid, simple and accurate reading and transmission of data for items that need to be tracked or managed. Bar codes can be printed directly on mailing tubes, envelopes, boxes, cans, bottles, packages, books, files and other paperwork, furniture, cards and many other items for identification.



The emergence of Auto ID systems, including bar codes and the related printers, scanners, decoders and software, has significantly increased the speed, efficiency and accuracy of data collection and entry. Early applications of bar code scanning, which included retail point-of-sale, item tracking and inventory control, have been expanded to include more advanced applications such as time and attendance, work-in-process, quality control, sorting, order entry, document tracking, shipping and receiving and controlling access to secure areas.

These expanded systems have measurably increased productivity by linking production, warehousing, distribution, sales and service to management information systems on a batch or real-time basis. Consequently, opportunities to improve operational efficiencies and customer responsiveness have developed for retailers, transportation and package delivery companies, manufacturers, wholesale distributors and service providers.



# BENEFITS OF BAR CODING

Bar code data-collection systems provide enormous benefits for just about any business. With a bar code data-collection solution, capturing data is faster and more accurate, costs are lower, mistakes are minimized, and managing inventory is much easier. The Following are some of the benefits of bar code data entry.

## Fast and Reliable Data Collection

- **Faster Data Entry:** A bar code scanner typically can record data five to seven times as fast as a skilled typist.
- \* **10,000 Times Better Accuracy:** Keyboard data entry creates an average of one error in 300 keystrokes. Bar code data entry has an error rate of about 1 in 3 million.

## Reduced Costs

- **Labor Costs:** This is the most obvious benefit of bar code data collection. In many cases, this cost savings pays for the entire data-collection system. Don't put all of your attention on this benefit, however. Even though this is the most apparent benefit, it is often overshadowed by even greater savings from other areas.
- **Reduced Revenue Losses Resulting from Data Collection Errors:** This benefit often surpasses the savings in labor costs. You know that if you make a significant error on an invoice in the customer's favor, you will hear about it immediately. In most companies, it doesn't take many errors to amount to a great deal of lost revenue.
- **Necessary Inventory Levels:** Using bar codes is one of the best ways to reduce inventory levels and save on capital costs. Keeping a tight handle on inventory can save significant amounts of money.

## Improved Management

- **Better Decision Making:** Although hard to measure, this is an important benefit. In many cases, improved management due to automated data collection technology could be the best benefit of a bar code system. A bar code system can easily gather information that would be difficult or impossible to gather in other ways. This allows managers to make fully informed decisions that can affect the direction of a department or company.
- **Faster Access to Information:** This benefit goes hand in hand with better decision making. With better information, you can gain opportunities and get the jump on competition.

## EXAMPLES

The following are just a few of the many ways bar codes are being used to improve the profitability and efficiency of a variety of company types.

### Point of Sale

Point of sale is one of the most common segments of the bar code market. Everyone is familiar with the scanners in grocery and department stores. Benefits of bar coding in point-of-sale systems include:

- **Cost Savings:** This is the most obvious benefit. A medium-to-large store can save enough checker time to significantly reduce payroll. You also save direct labor costs through less time spent taking inventories and ordering product.
- **Customer Satisfaction:** A proper bar code system will speed customer checkout. This will improve customer satisfaction enough to directly increase revenue over time.
- **Reduced Inventory Costs:** Immediate access to inventory information on a real-time basis can be used to reduce inventory levels. This will reduce costs for a company in a number of ways, including interest, labor for handling excess inventory, and facility overhead.
- **Automated Reordering:** Accurate stock levels allow for automated replenishment of low inventory.
- **Better Decision Making:** With bar code data-collection you can tell not only what the customers are buying, but when they are buying it and in what combinations. This can improve business management by suggesting better locations for goods in the store and identifying advertising targets.

Point-of-sale systems can be used in any retail setting. The grocery industry is the best organized setting, but most vendors in that area are concentrating on high-end scanner/mainframe systems. There are abundant opportunities for PC-based systems in small to medium-sized businesses, such as video stores, convenience markets, and clothing stores.

### Work In Progress

Many manufacturing and other industries have work that must go through several steps to completion. Bar code systems can track material through each step of the work and keep detailed records on each piece or batch. When a problem occurs in the output, supervisors and managers can track the work back and quickly resolve the issue.

This is one of the best ways to improve both quality and yield in virtually any multi-step process.

## **Inventory Control**

Tracking inventory manually is a laborious process. With bar codes applied to each item in inventory, portable scanners can be used to track shipping and receiving and quickly take physical inventory. The data from portable scanners can be uploaded to a central computer system at regular intervals or portables can update inventory in real-time, depending on the system you choose.

Bar code inventory control provides accurate, real-time inventory updates. This allows a company the opportunity to reduce stock levels and thereby reduce carrying costs. It also reduces the time taken to collect data for purposes such as annual inventories. With improved efficiency, operating costs are lower.

PSC markets IntelliTrack® inventory management software. Different modules of the software target different applications of inventory control, including fixed asset tracking, inventory management, check-in and check-out tracking, and stockroom management. Contact your reseller or PSC for details.

## **Secured Access**

A secured access system provides door and gate security by controlling access using encoded employee identification badges. Bar code badge scanners or magnetic stripe readers are mounted at doors and gate entrances, and authorization is provided from a central computer.

## **Time and Attendance**

A time and attendance system uses encoded employee identification badges that are scanned when employee start and stop work. This allows automatic tracking for payroll and eliminates paper time sheets and time clocks.

## **Quality Control**

Bar code systems in quality control can be used to tell a person which test to perform for a given part and where to send it if it fails. Bar code systems can also create permanent records for tracking component and subassembly failures.

## **Packaging**

For packaging, a bar code printer is used to generate a label to identify part numbers, serial numbers, and shipping information. This labeling can be used to automatically sort packages for shipment, automate receiving, and greatly enhance package tracking.

## Collection of Data from Forms

Businesses such as medical and dental practices rely on complex patient forms. Using bar codes, detailed information can be quickly entered in the computer. Bar codes printed by check boxes on a form allow fast accurate data entry by simply scanning the codes by the check boxes. This makes any easy task of gathering large amounts of information for a client. Reduced data collection costs and better service are the results.

## Productivity Measurement Systems

Productivity measurement is a practice that can drastically reduce labor costs in manufacturing, warehousing, and most other types of business. A well-managed system will allow supervisors to isolate the problems that may come up so that they can take steps to solve them.

Within an organization, departments may have different types of activities, making it difficult for supervisors to keep track of what everyone is doing. Productivity-measurement systems automatically track what work is being done and compare the work to expected output. When the results do not measure up, supervisors can take corrective action.

This type of informed supervision and management can typically cut department costs by 15 to 20 percent.

## Summary

There are just a few examples to get you started thinking about what you can do with bar codes. Bar code systems routinely save companies money while improving quality, on-time performance, and other key business factors.

# DATA-COLLECTION TECHNOLOGY

## Portable Data Terminals

Portable data terminals (PDTs) are handheld battery-powered durable computers. Data can be entered either manually through an input device such as an integrated keypad or automatically through a wand, CCD or handheld laser scanner. PSC's Falcon® PDT a 32-bit, 386 microprocessor DOS-based unit, weights just 14 ounces, and is available in both batch and RF modes. Falcon® RF supports wireless LAN technologies through a user accessible PC-card slot. Through this PC-card slot the unit supports RF communications — principally 2.4 GHz radio solutions offered by multiple vendors, memory cards and modems. PSC also markets the PT 2000® and TopGun® portable data terminals.



## Handheld Scanners

QuickScan® and PowerScan™ families of handheld laser scanners, are input devices that use scanning technology for data collection. These input devices permit non-contact scanning of bar code labels on flat, curved and irregular surfaces upto distances of 60 feet and come in undecoded , decoded and RF models. Decoded models can be connected to any supported PC or terminal as either a keyboard wedge or a serial device. Undecoded models can be used with the PSC's PowerWedge® decoders (or similar decoders) or with PDTs.



## In- and On-Counter Scanners

These types of laser scanners are non-contact scanning devices which are used for medium-to-high volume retail scanning environments such as supermarkets,

hypermarkets, drug, convenience and specialty stores. They easily connect to your point of sale terminals for data collection and reporting.



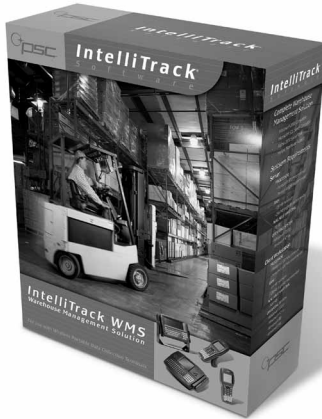
## Fixed Station and Integrated Decoders

PowerWedge®, PSC's family of fixed station decoders, are bar code readers designed to be connected in series with the keyboard of either a PC or a computer terminal or attached to a serial port on a host computer.

Bar codes scanned by the decoders are translated into data used by the PC or terminal as if the data originated from the keyboard.



## Application Software



Application software consists of PC-based computer programs that permit the storing, management and reporting of data.

Data can be uploaded or downloaded into these programs with PSC's PDTs. PSC offers IntelliTrack® data management software, which include applications for fixed assets, inventory, and shipping and receiving; Universal Program Generator (UPG); Portable Applications Library (PAL), which

includes seven standard applications; and PSC Program Generator (PPG), UPG and PPG are Windows®-based program

generators that allow greater ease of programming and customizing of PSC's portable terminals. You can create custom programming of other leading DOS-based portable data terminals with UPG.

## TYPES OF DATA-COLLECTION SYSTEMS

Bar code data-collection systems fall into three basic types: interactive, batch, and hybrid.

- An **interactive system** consists of one or more portables connected in real time to a computer. In these systems, the central computer manages data collection and verification as the user enters data.
- A **batch system** uses one or more portables to gather data that is stored for later input to a computer. This is the most common and most economical portable system. Batch systems can do only limited validity checking.
- A hybrid system is a combination of the two.

### Interactive Systems

Interactive systems have several advantages over batch systems. Almost all systems where bar code hardware is in a fixed location are interactive systems. Advantages include:

- **Immediate Data Verification:** As the user enters data, the computer can check its validity and give the user variable responses depending on that validity.
- **Sophisticated Data Verification:** An interactive system can check many more variables when performing data verification. For example, a batch system can check the status of a part number only against the last part numbers that were sent to the portable. An interactive system can check the status of a part number against the entire inventory at any time.
- **User Interaction:** Interactive systems can give the user better feedback when an error occurs. Since the system can check more variables, you can tailor the responses given to the user to solve problems.
- **Error Reduction:** All of the above advantages tend to reduce errors in an interactive system. This reduces the labor cost to correct the errors, as well as the consequences of acting on incorrect data.
- **Easy Setup:** Interactive systems use standard programming techniques and error checking, much like programming for PCs. You can process each transaction and verify data in real time. Batch processing requires a way to process data in batches and a mechanism for correcting errors after the fact.

## Batch Systems

Batch systems are generally used with portable readers. They are also used in some fixed-mount systems where the reader must continue to collect data if the computer system goes down. While interactive systems are superior in the ways listed above, batch systems do have some advantages:

- **Economical for Standard Portables:** Portables can be used for batch or real-time applications. Real-time applications require a costly radio frequency (RF) network. On average, setup costs for batch systems are less than half the costs of RF systems.
- **Reliable in Mission-Critical Applications:** Since batch processing distributes data collection to stand-alone units, operation is not dependent on the central computer. If a particular unit fails, it can be replaced. If the central computer ails, data collection can continue.

## Hybrid Systems

Several systems combine attributes of both interactive and batch modes. The most common are radio frequency systems and batch/interactive hybrids.

- **Radio frequency systems** use RF signals to connect portable readers to a central computer in an interactive manner. This gives the advantages of an interactive system combined with portability. There are different types of RF:

The simplest RF bar code device is a portable scanner that communicates with a single receiver connected to a computer or terminal.

Another type of RF system connects a portable to a typical computer network through an RF access point. This has many advantages, such as the ability to “roam” from one access point to another. The range could be virtually unlimited, depending on the number of access points. PSC’s Falcon® can be utilized in this manner.

- **Batch/interactive hybrids** use local batch processing combined with an interactive link to a central computer. These work primarily as interactive systems, but they can function independently for a period of time if the central computer fails. These systems are best used for mission-critical applications where data collection is essential.

While most batch systems simply upload data to a central computer, **dual mode batch systems** can also download data from the computer to the batch system and use it for data verification and other uses. These are not quite so good as real-time interactive systems, but they are better than straight batch systems.

**Multiple interactive systems** connect more than one interactive system to a network. This way, if one computer fails, another can still manage critical parts of the system.

## BAR CODE SYSTEMS

Bar code systems require three elements:

- **Origin:** You must have a source of bar codes. These can be preprinted or printed on demand.
- **Reader:** You must have a reader to read the bar codes into the computer. The reader includes an input device to scan the bar codes, a decoder to convert the symbology to ASCII text, and a cable to connect the device to your computer. PSC markets a line of decoders, called PowerWedge®, that require input devices. PSC also markets a variety of handheld products, which are decoders and input device all in one.
- **Computer System:** You must have a system to process the bar code input. These can be single-user, multi-user, or network systems.

We will discuss each of the elements in turn in the next section.

# ORIGINS OF BAR CODES

A bar code system must have a source of bar codes and a way to read them. Bar code labels fall into one of the following categories: preprinted or printed-on-demand.

## Preprinted Bar Codes

Using preprinted labels is the most economical way to get high-quality bar codes. This places some restrictions on you, because the information in the bar codes must be determined in advance. In many cases this is acceptable, but in some it is not. Preprinted bar codes are used where very durable, high-quality labels are necessary to withstand the environment (such as on printed circuit boards), or where high-volume packaging or labeling is done. Examples of preprinted bar codes are:

- ***Bar Codes on Packaging:*** The most common example of preprinted bar codes are those you see on packaging for retail sale. Grocery stores are the most common application, but the system is gradually working its way up the manufacturing chain.
- ***Stickers or Tags:*** In many cases, you need to identify a particular item as unique. There are several companies that will print stickers, pallet tags, item tags, or other types of very high quality bar code labels in any required sequence.

Either of these systems works very well when you can manage the assignment of codes beforehand.

In many cases, you can also use assigned codes by generating a correlation between the bar code and another significant value. For example, you could use a randomly numbered sticker or tag and have the user type in the corresponding invoice number, control number, or other information that goes with it.

## Printed-On-Demand Bar Codes

On-demand bar codes are used where the bar code must contain some information that is available only when the bar code is generated. PSC produces products to help with creating on-demand bar codes.

On-demand bar codes can be produced in small quantities for less money than preprinted bar codes, and in less time. They can be printed with:

- ***Dedicated Bar Code Printer:*** These produce very rugged bar codes. Dedicated printers come in several varieties, including thermal and thermal transfer. The best of them can produce bar codes that are not bothered by acid, rain, sunlight, or various other problems. These printers can also print a single tag or sticker easily and remove the label backing automatically.

- **Laser and Ink Jet Printers:** Bar codes printed by these printers are comparable to those printed on dedicated label printers. In fact, the print quality is almost as good as on preprinted bar codes. However, laser printers are not quite so rugged as dedicated label printers, and they print a full sheet of labels at a time.
- **Label Printers:** Avery™ and Costar™ make small, thermal label printer that can print bar codes. These printers may not be the best choice for high-volume printing.

## READING BAR CODES

Once you have a bar code in hand, you must read it and process the information. Reading bar codes requires three basic decisions. You must decide on the input device, the decoder, and the interface. The input device reads the bar code and transmits the data to the decoder, which converts the data to ASCII characters. The interface is the connection between the decoder and the computer.

### Input Devices

Input devices (wands, CCDs, badge scanners, and lasers) are the direct contact between the user and the bar code. No other choice you make will have a greater impact on the usability of the system. Naturally, there are several choices, in a range of prices. In general, you will get better service from more expensive devices, but this is not automatically so. The choice of input device is controlled by these factors.

- **Volume:** Some input devices are inherently more usable and reliable than others. If you have a low-volume application, any input device will probably work well for you. A high-volume operation will generally be better off with a high-grade input device. High-grade input devices are fast and reliable.
- **Bar Code Quality:** One of the advantages of high-grade input devices is their ability to read low-quality bar codes. In applications where bar codes are of poor quality to start with or are likely to be damaged, use of high-quality input devices can save time and reduce errors.

To select an input device, you must take all of these factors into consideration. Once you have made a tentative decision, you should test the system in as many real-world conditions as you can simulate.

Get the input device a little dirty, damage the bar codes, print them with a slightly worn ribbon or cartridge, test it with an untrained employee, and try to anticipate other problems that may happen during normal operation. This way you can make sure you have made the right choice. The most common input devices are:

- **Wands:** These are the most inexpensive input devices available (\$140 to \$180). They work well for low-volume scanning but have some disadvantages. They require a relatively flat surface, a fairly high quality bar code, and some skill on the part of the person operating it. However, in applications where someone must scan one bar code on a sheet full of bar codes, these are a good choice.
- **CCD (Charge-Coupled Device) Readers:** these are the next step up from wands (\$400 to \$600). A CCD has a read head the same width as the bar code (2 to 4 inches). The user sets the head of the reader on the bar code, and a series of LEDs scan the bar code and read it. This requires less skill than the wand, and it will work with most low-quality bar codes. They still require a relatively flat surface, and the CCD must be within 0.25" / 0.5 cm of the bar code to read it. The surface can be slightly curved in the direction of the bars, but no more than about the curve of a 1-liter bottle.

- **Laser Scanners:** These are the best type of input device and are therefore the most expensive (\$400 to \$1,300). They will work with curved or uneven surfaces and will read most very low quality bar codes. They will also read over a much greater distance than wands or CCDs, usually 5" to 27" / 12 to 65 cm. Laser scanners come in general-purpose and heavy-duty versions.
- **In &/or On-Counter Laser Scanners:** These systems use laser readers that are fixed in place, and the bar codes are brought to the scanners. The most common example is the scanners used in grocery stores. Another example is a conveyor controlled that reads the labels on boxes or packages as they move down a line. These are used in the airline industry to process baggage, in warehousing to control conveyors or other devices, and in many types of manufacturing.
- **Slot Scanners:** Slot scanners are used for time-and-attendance, security, and other systems. Each scanner has a slot that you slide bar coded cards through. These scanners look much like the credit card readers you see in real settings, but they read bar codes instead of magnetic coding.
- **Combination Scanners:** You can frequently mix two different types of input devices. For example, you can attach a slot scanner and a laser scanner to a decoder to allow users to enter information either way. PSC's PowerWedge® 20 dual model is such a device. Many models allow you to attach magnetic card scanners to bar code readers. This way, you could process credit or ATM cards with the same system that reads bar codes on packages.

## Interfaces

Once you have selected an input device, you must select a decoder and the type of interface to the computer. Most batch systems use a periodic download over serial ports, and you don't have much choice in the interface method. Interactive systems have a choice of several interfaces.

When choosing the interface, you must keep the following factors in mind:

- **Existing equipment:** If you plan to use existing equipment (computers, terminals, etc.), you will need to make sure the interface type you choose is compatible with the equipment you currently have.
- **Data Reliability:** Interface types vary in ease of use. One interface may allow the user to affect the data, while another may not. This does not mean that one interface type is inherently better than another. It does mean that where user error can affect data, more follow-up will be required.
- **Locations of Readers:** The location of the readers can have a profound impact on the design of the system. For example, most shop floor environments are too crowded or are unsuitable for PCs. This limits the type of system interface you can use.

As with the input device, you should test the system architecture you choose in as many real-world conditions as possible. Interfaces come in these basic types:

## Interactive Systems

- **Wedge Readers:** These systems are the least expensive and the easiest to implement. The bar code reader connects between your keyboard and your computer and simulates keyboard input. The application program does not know the difference, and the user can always type in the numbers if the bar code is unreadable. This is the best choice in many cases.
- **Serial Readers:** These systems are more flexible than the ones using wedge readers. In this case the reader is connected to the computer or terminal over a serial port to the computer. Since serial communication is standardized, you can typically use a serial decoder with almost any computer or terminal (cabling may vary). Serial readers are ideal for terminals, since most terminals are serial devices themselves. If your terminal does not have a port available for a serial scanner, you can use a “serial eavesdrop” cable to connect the scanner between the terminal and the host computer.

When using serial scanners with PCs, keep in mind that your application needs to “monitor” the serial port for incoming data. Most applications do not do this, and so an additional piece of software, called a “software wedge,” may be required.

- **RF Network:** Portable bar code readers are generally connected to a system through a modem or a serial port and processed in batch mode. However, they can also be connected through a radio frequency system (\$4,000+). With the right software, the portable can be made to have real-time access to a database on a networked computer.

## Batch Systems

- **Serial Portables:** This is the most common use for portable bar code readers (\$500 to \$2000). An application in the portable allows the user to collect the data. After the data has been collected, the user connects the portable to a computer through the computer’s serial port and uploads the data. The data then resides on the computer in the form of a text file. It then must be processed or imported into the main database.
- **Wedge Portables:** Some models of portables (\$500 to \$2000) allow uploading of information through the computer’s keyboard port. PSC’s PT 2000® and TopGun® can be made to operate in this manner. The portable essentially simulates a live typist. One advantage to this method is that it eliminates the need to import data. The data goes directly into the database via the same application in which a user would type data. A disadvantage to this method is the need for portable program customization. The program in the portable would have to output data in the exact same manner as the receiving computer inputs it.

## OPERATING SYSTEMS

Once you have decided on the scanner technology, you must design the system. These systems can be set up in several configurations. Some applications will work with only one particular system type, but most applications allow you to select the system to meet the best cost/performance requirements. The basic system types are:

- **Single User:** These systems use a single PC with a single bar code reader to process data. These are generally the best type of system to start with, as they give you experience with bar code technology without some of the complexities of multi-user systems. An example of a site with a single-user system is a small video store that uses a wand to read bar codes on movies and stickers on customer cards. The store might also use a slot scanner for customer cards.
- **Multi-user:** This was once the most common type of system. It consists of a single computer that is hooked to several bar code readers, terminals, or both. A multi-user operating system manages the data collection.
- **Local Area Network:** These systems connect several essentially single-user systems and a common file server using a network. These are the most flexible systems and currently the most popular.
- **Portable Systems:** Prices of portables have fallen over the last few years, making portables one of the best solutions for bar code applications. Portables are used with computers to keep data current either in real time or in batch mode.

## Single-User Systems

A single-user system is simply a PC with a bar code scanner attached. The system generally uses a wedge to simulate keyboard input. A wedge can be used with any PC that has the same keyboard interface as the wedge. Most computers have either a DIN connector (like that on IBM computers through the AT) or a PS/2-style keyboard connector. A few companies make their own, nonstandard keyboard connectors. You must be sure to get the right kind of wedge for the computer you are using.

The normal action of a bar code reader is to simulate typing the keystrokes for the characters in the bar code and then press the Enter key. You can change the Enter key to a tab key or any other key for specific situations.

When the reader must be remote from the PC or terminal, you can later connect the reader to a serial port and use a "software wedge" to send the data into the keyboard buffer. Another possibility is to write the application so that it monitors the serial port for incoming data. Serial decoders are also useful if you must support a computer that uses a non-standard keyboard interface and when you want to use a single bar code reader with a combination of PC, Macintosh, or UNIX systems. Software wedges are available for a variety of operating systems.

## Multi-user Systems

Multi-user systems have traditionally been the most common type of bar code system. This system uses serial ports to connect a single PC or other computer system to multiple bar code readers, terminals, or both. Each terminal runs a single session on the multi-user operating system. Cheaper PC prices and the availability of very basic network PCs will undoubtedly sway some users away from multi-user systems. Clearly the multi-user system is on its way out.

This type of system requires a multi-user operating system. If you want to use terminals with bar code readers attached to them, you can use any multi-user operating system, such as DR Multi-user DOS, VM-386, or UNIX.

## Networks

Networks work just like several single-user systems connected together to share data. These work much like the multi-user systems shown above, except that each station is able to run any application. Networked PCs can run graphics-based and text-only applications and perform any other MS-DOS or Windows® functions. The multi-user systems mentioned above will work with any text-based program.

Networks provide this flexibility at the expense of cost. Even an inexpensive network, such as Lantastic™ or Netware™ Lite, will cost several hundred dollars per station more than a similar multi-user system. A high-performance system, such as Netware, costs around \$350 per station (with a network card) for a 10-user version. These systems also require a PC at each station.

You must also be careful of security with PCs. Most PCs have a floppy disk drive, which makes them susceptible to security violations. Multi-user systems are more difficult to exploit.

## **Portables**

Portables are most often used in conjunction with a computer system for a bar code application. They can be used with a single-user, multi-user, or network system. Each portable has its own operating system and program. PSC's portables come with the Portable Applications Library, or PAL, which is a collection of basic inventory-collection programs. PAL works fine for very basic applications, but often you will want to customize the software in the portable. For example, PAL allows the user to collect item and quantity data. To collect item, location, and quantity data, you would need a custom program. At PSC we sell programming tools that allow non-programmers to develop applications such as this. Alternatively, you could have your reseller call our **PSC Solutions Group (PSG)** to do the programming job for you.

# DEVELOPING A BAR CODE SYSTEM

## Single-User Systems

If you wish to create simple single-user systems, all you need is a wedge reader to connect to your PC. If you wish to print on-demand bar codes, you will also need bar code printing software. There are many good products on the market today.

Since a wedge reader simulates keyboard input (it connects between the CPU and keyboard), you simply plug it in and scan the bar code. You can improve the reliability of your scans when printing on-demand bar codes by encoding a special character into the bar codes. For example, you could put an “E” at the beginning of employee badge numbers, and a “D” before a department number. Then you can check for this when a field is read to be sure that the user is not scanning the wrong type of bar code.

## Multi-user Terminal-Only Systems

While these are still being sold, most companies have discontinued them. There is a chance, however, that you already have one of these in place. If that is the case at this point you need to decide if you want to replace what you have with PCs or just add to your existing system. It is very easy to add to an existing system, as it is still possible to buy extra terminals and add bar code equipment to the ones you have.

## Network Systems

If you want to build a network system, simply attach a wedge reader to each workstation and write a standard network application. Our IntelliTrack® products are available in network or single-user versions.

## Expansion

Be sure to look at your company's future as well as its current needs. You should plan on expanding virtually every system you install, because you will definitely see a benefit. Don't install a system that you will not be able to expand in the future. In particular, keep these factors in mind:

- **Extra Terminals or Stations:** In about 90 percent of installations, one or two additional workstations are added within the first month of installation. Try to make it a normal practice to bid the original system with some allowances for expansion. Add a few extra megabytes of RAM to the system and a larger hard drive than you think you need.
- **Wiring:** Wire for extra workstations can usually be added when the cabling is pulled with virtually no extra costs. Be sure to pull some extra cables if you can, at least in the more difficult runs.

- **Network Length Limitations:** Many networks have a definite length limitation for the total cable making up the network. These limitations are most prevalent on Ethernet networks. Don't select a network that does not allow a few extra terminals to be added easily.
- **Speed:** Do not get the slowest computer you can get away with. In most cases you are much better off obtaining better performance for a little extra money. Be sure to use the best disk cache you can, and don't skimp on RAM.

## Reliability

- **Power Supply:** In all systems you must ensure that each workstation has a clean and reliable power source. In most cases you can use any convenient power outlet. In industrial situations it is always a good idea to add a surge suppressor to the equipment at installation. In manufacturing environments with large equipment, you may need a dedicated power line, an uninterrupted power supply, or both.
- **Backup Hardware:** As a system is integrated into a process, it will gradually become a more critical. Try to have backup hardware somewhere to take care of the inevitable failure. In many cases, you can keep a spare PC in use for another purpose as long as it can be quickly brought on line in case of a failure. Be sure to keep the software on the spare PC up to date so that it can be switched quickly. Insist the company purchase a tape backup system and schedule it for automatic daily backups.
- **Utilities:** When you install a system, take care to include diagnostic and troubleshooting utilities to take care of inevitable problems. You should always include some disk and virus-detection utilities.

## BAR CODE SYMBOLOGIES

Bar code systems can use several symbologies. A symbology is equivalent to a language. Each symbology has strengths and weaknesses. Many symbologies are around for historical or political reasons, while others have definite technical advantages.

In many systems, you must conform to a company-specified symbology. If this is the case, then you don't have much choice unless you can give the company a good reason to change. In other systems, you are given the choice to use any symbology you wish. Choose your symbology carefully. There are several factors to use in choosing a symbology, including:

- **Symbol Set:** All symbologies have some limitations on the number of characters that can be encoded. UPC (Universal Product Code) is the most limiting. It is a numeric-only bar code that must consist of 11 digits. Furthermore, the value of these digits is determined by a grocery industry committee. Code 128 is the most flexible, with the full (128-character) ASCII set available.
- **Standards:** Many bar code applications must share common bar codes between different vendors. The UPC symbology has a standards committee that assigns manufacturer and product codes for well over one million products. That is the reason that a product manufacturer can put a bar code on a package without fear of duplication. If you are in a situation where some type of industry committee has set up standards, it is frequently in your best interest to conform to that standard, even if it imposes other limitations.
- **Density:** Each symbology can encode a different number of characters in a given space with all other factors being the same. Numeric-only bar codes such as Interleaved 2 of 5 can encode many more numbers in a given space than a more flexible symbology such as Code 128. In many cases this is critical. Even if one symbology is capable of making a bar code of the required size, you may get a better first read rate using a different symbology. Note that some scanners, particularly wands, are built for a particular density. Make sure that your input device matches the density of the bar code you will use.
- **Readability:** Some bar codes are inherently more readable than others. For example, our tests show that Code 128 (which is one of the most flexible symbologies) is easily and successfully read by most readers. This is a case where the symbology is better in nearly every way than the competition. In other cases, you may sacrifice readability for some other requirement. Always use the most readable symbology you can, and test it using the actual equipment you plan to use.
- **Durability:** Some symbologies are more durable than others. As a rule of thumb, those with better readability are more durable than others. You should always test your bar codes by subjecting them to some abuse and making sure your equipment will still read them.

- **Setup:** Many bar code readers have certain symbologies disabled in their default configuration. If at all possible, it is best to use a symbology that the reader will read “out of the box.” This will cut down on your setup time and reduce user confusion when a reader is added or replaced. If a new reader requires configuration, be sure to leave detailed instructions and materials at the site. (Keep a copy for yourself for when users lose the ones you gave them.)
- **Acceptance:** Your bar codes may need to be compatible with those of companies you do business with. Whenever possible, use symbologies that are already in place.
- **Conflicts:** Your bar codes should avoid conflicts. For example, if you disable symbologies that you’re not using, you can keep an employee’s candy bar out of your inventory.

To summarize: For general-purpose use, Code 128 is usually the best choice. It provides use of the full (128-character) ASCII set as well as the best readability and reliability available. If you are making a general-purpose system that needs to read only numbers and uppercase letters, you can use Code 39. If you need numbers only, you should use Interleaved 2 of 5 or Code 128. In any case, avoid symbologies that require reconfiguration of the reader, and your life will be easier.

## Checksums

Checksums are additional characters appended to bar codes to guarantee good reads. Checksums are necessary on some bar codes that are prone to errors. For example, Interleaved 2 of 5 is a very dense, numeric-only bar code, but it is prone to substitution errors. You should always use a checksum on this code. Other codes, such as Code 128 and Code 39, are self-checking and seldom require a checksum.

Most bar code readers can be configured to use checksums in these ways (on symbologies where there is a choice):

1. Do not expect a checksum.
2. Use a checksum to guarantee a good read.
3. Use a checksum to guarantee a good read, and pass the checksum on to the computer system.

Choice 2 is generally the best. Some symbologies, such as UPC, require a checksum, and the checksum processing is invisible to the programmer. And guarantees only a good read. It does not guarantee a good connection to your computer.

Choice 3 guarantees both a good read and a good connection between the computer and the bar code reader. It requires special software on the computer to verify the checksum. This gives the most secure system, but at the expense of extra logic in your program.

## Code 128

This symbology is a very compact bar code for all alphanumeric applications. The full (128-character) ASCII character set can be encoded in this symbology without the double characters found in extended Code 39. If the bar code has four or more consecutive numbers (0-9), the numbers are encoded in double-density mode (where two characters are encoded into one character position). Code 128 also has five special, non-data function characters. These are generally used to set reader parameters or return parameters.

*Figure 2:* A Code 128 bar code



Code 128 actually has three different character-code subsets. It has two forms of error checking, making it a very stable bar code. Checksums are not required. If you have your choice, Code 128 is generally the best all-around choice you can use.

## Code 39

Code 39 (or Code 3 of 9) is the most common bar code in use for custom applications. It is popular because it can support both text and numbers (A-Z, 0-9, +, -, ., and <space>), it can be read by almost any bar code reader in its default configuration, and it is one of the oldest of the modern bar codes. Code 39 is a variable-width bar code, and it can support any number of characters that the reader can scan. Code 39 is specified in many military and government specifications. Code 39 bar codes are self-checking and are not prone to substitution errors. They generally do not require checksums.

*Figure 3:* A Code 39 bar code



## Interleaved 2 of 5

Also known as I2of5, this is a numeric-only bar code that prints out a little larger than the UPC-A bar code when 10 digits are encoded. This symbology has the flexibility to encode any even number of digits. If you have an odd number, a leading zero is added.

*Figure 4:* An I2of5 bar code



This bar code is an excellent candidate for numeric-only applications, and it is the best symbology to use for fixed-mount readers. Because Interleaved 2 of 5 is prone to substitution errors, you should always use a checksum.

## UPC (Universal Product Code)

UPC is the standard bar code for items for sale to the public. It is the code seen on items at the local supermarket. UPC-A is a fixed-length, numeric-only bar code. It contains 1 digit for a system number, 5 digits for the manufacturer number, 5 digits for the product number, and one checksum digit. The position and value of the digits is standardized by a grocery industry committee. UPC-A and UPC-E also allow two- or five-digit supplemental numbers. UPC-A and UPC-E codes have an automatic checksum.

UPC-E is ideal for small packages, because it is the smallest bar code available. This symbology contains the same information as UPC-A, except that at least four zeros are suppressed. Only tags with the system character of 0 can be encoded with this symbology. UPC-A and UPC-E codes have an automatic checksum. Interleaved 2 of 5 is almost as dense and does not have the format considerations.

*Figure 5:* A UPC-A bar code



## Extended Code 39

Extended Code 39 is a derivative of Code 39. This symbology uses combinations of two standard Code 39 characters for every character in the ASCII character set (0-127). This symbology allows lowercase letters and control characters, at the expense of size. This makes the code very big if you have very many lowercase or special characters.

Most bar code readers in their default configuration will not read Extended Code 39. If you want to use this symbology, you will probably need to configure the readers.

If you need to read both uppercase and lowercase, you should use Code 128.

## Code 93 and Extended Code 93

Code 93 and Extended Code 93 are compressed versions of Code 39 and Extended Code 39. This symbology supports the same characters as Code 39, but in a smaller character width. This is a more difficult symbology to read, and many readers do not support it. Both Code 93 and Extended Code 93 have automatic checksums.

## UCC 128

This bar code is a 19-digit, fixed-length bar code that used Code 128 C to generate the bar code. This bar code is specifically used on shipping containers by those who ship items with UPC codes. UCC 128 has automatic checksums.

## Codabar

Codabar bar codes can include numeric characters, six punctuation characters (-\$/.+), and spaces. There are also four special start/stop characters, which are A, B, C, and D. Codabar is useful for encoding dollar figures and mathematical figures. These bar codes are slightly larger than Interleaved 2 of 5 bar codes.

Codabar requires start and stop characters. The Codabar symbology is self-checking, but you can use a mod 16 or mod 10 checksum.

## EAN/JAN

The EAN/JAN-13 code is used for overseas applications where a country code is required. The UPC-A symbology is actually a subset of the EAN/JAN-13 symbology. This bar code is composed of 2 numbers for the country code, 10 numbers for the data characters, and a checksum. The checksum is generated automatically

*Figure 6:* An EAN-13 bar code



The EAN/JAN-8 code is also used for overseas applications where a country code is required. This is similar to the EAN/JAN-13 except that only 5 numbers are used.

## MSI

The MSI bar code is used most often in the grocery industry for shelf labels. This is a numeric-only code that stands up well to wear and tear.

This code is not self-checking, and so a checksum is highly recommended. It support three types of checksums.

## Zip+4 and DPBC POSTNET

This bar code is the special code that is placed on the lower right portion of any envelope. This bar code is used to speed mail through the postal service (by automated sorting) and get reduced rates.

*Figure 7:* A DPBC POSTNET bar code



## 2D (Two-Dimensional) Bar Code Symbologies

A 2D bar code symbology allows vast amounts of data on a single bar code by storing data in 2 dimensions. A common demonstration of the technology is a single bar code no larger than a standard UPC bar code that contains the entire Gettysburg Address. Some common 2D bar code symbologies include PDF 417, DataMatrix Code, and MaxiCode.

## Symbology Summary Chart

The chart below summarizes the different characteristics of the various bar code symbologies.

Symbology	Length	Checksum*	Characters**	Notes
Code 39	2-30	NR	N, U, P	Most common bar code
Code 128	2-30	Auto	N, U, I, P, C	Best for full ASCII character set
I 2 of 5	2-30	Recmd	N	Most dense numeric code
UPC-A	11, 13, 16	Auto	N	Grocery standard
UPC-E	11, 13, 16	Auto	N	Small packages
EAN/JAN-13	12, 14, 17	Auto	N	UPC + Country Code
EAN/JAN-8	7, 9, 12	Auto	N	UPC + Country Code
Extended 39	2-30	NR	N, U, I, P, C	Lowercase/Ctrl — very wide
Codabar	2-30	NR	N	Requires start/stop (A, B, C, or D)
Postnet	5, 9, 11	Auto	N	Positioning critical
MSI	2-30	Recmd	N	Very durable
Code 93	2-30	NR	N, U, P	Higher-density Code 39
Extended 93	2-30	NR	N, U, L, P	Higher-density Extended Code 39
UCC128	19	Auto	N	UPC Shipping containers
<b>*Checksum</b>		<b>**Characters encoded</b>		
Auto = Automatic checksum—Always required		N = Numbers (0-9); U = Uppercase (A-Z)		
NR = Checksum not required—Self checking		L = Lowercase (a-z); P = Punctuation		
Recmd = Checksum highly recommended		C = Control characters (-32)		

## More Information on Bar Code Technology

For more in-depth information on bar code technology, an excellent reference is *The Bar Code Book*, by Roger C. Palmer (published by Helmers Publishing, Inc., Peterborough, NH, 603-924-9631).

**PSC Inc.** is a recognized leader in providing a complete line of low-cost, high-performance products—including portable data terminals, decoders, input device, in- & on-counter scanners, handheld scanners, and data-management software—to companies seeking to improve productivity and inventory management through the use of bar code-based data collection.

**PSC products** are used in a variety of industries, including retail, package delivery, warehousing, and distribution, manufacturing, healthcare, and other point-of-sale/service applications. Contact PSC today for more information about our cost-effective bar code solutions.

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