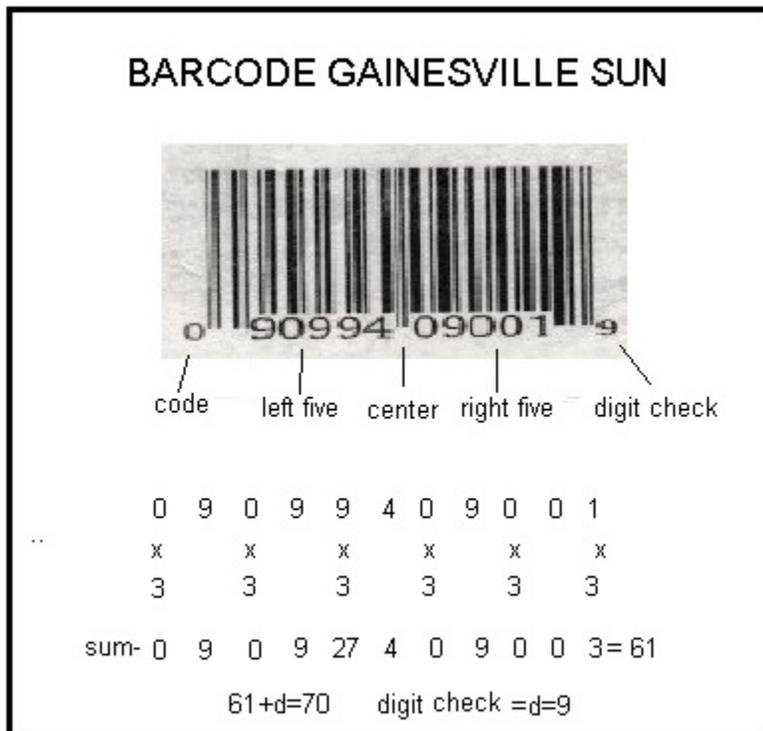


## BAR CHARTS AND BARCHART READER

One of the most significant inventions in the last fifty years has been the barchart and related support structures. It allows one to identify electronically any one of millions of items using a high speed optical reader for quickly identifying the item via a small label (barchart) present on the item. It has revolutionized the check out procedure at grocery stores and allowed for instantaneous checks on inventory. It is now used worldwide in multiple different industries using one of many different reader codes.

The bar chart idea goes back to a 1952 US patent by the inventors Joseph Woodland (1921-2012) and Bernard Silver(1924-1963). They used a circular bar representation. The actual simplified version of barcharts was discovered some twenty years later by George Laurer (1971-2019) of IBM. He introduced the parallel black-white line bar chart and an accompanying Universal Product Code(UPC)which is still in active use today. We want in this article to present details of the UPC bar code, show how it is constructed, and then, how it is scanned using an optical reader.

Let us begin with a simple active bar chart. Here is the bar chart for our local newspaper, the Gainesville Sun-



We see that it uses white and black bars representing a total of twelve numbers. The first number 0 is an indication that we are using the UPC code, the next five numbers represent the manufacturer. This is followed by the second five numbers designating the item and finally the digit check number of 9. These days the ten numbers in the middle will often mix the manufacturer and item numbers together making it impossible to

identity the manufacturer. We also show on the bottom of this figure how the digit check is derived. Note the first and last number are slightly smaller and set a bit lower. Also a pair of lines extending somewhat lower indicates a space in the representation.

Now the actual numbers read by an optical scanner are the white and black bars in the code. The black white character is reversed in the second five group. These bars represent essentially the nine numbers zero through nine, with each letter consisting of a total of seven equal width bars. The breakdown used in the UPC code are as follows-

INTEGER	SEVEN DIVISIONS
1	W W B B W W B
2	W W B W W B B
3	W B B B B W B
4	W B W W W B B
5	W B B W W W B
6	W B W B B B B
7	W B B B W B B
8	W B B W B B B
9	W W W B W B B

All integers 0 through 9 are represented by 7 equal width strips with the first strip always white(W) and the last black(B)

Note from the above barcode for the Gainesville Sun, that the number 9 in the left five section reads-

$$9 = WWW + B + W + BB$$

That is, we have three white strips followed by a black strip, followed by another white strip and finishing with two black strips. In the right section window things reverse and 9 becomes BBB+W+B+WW.

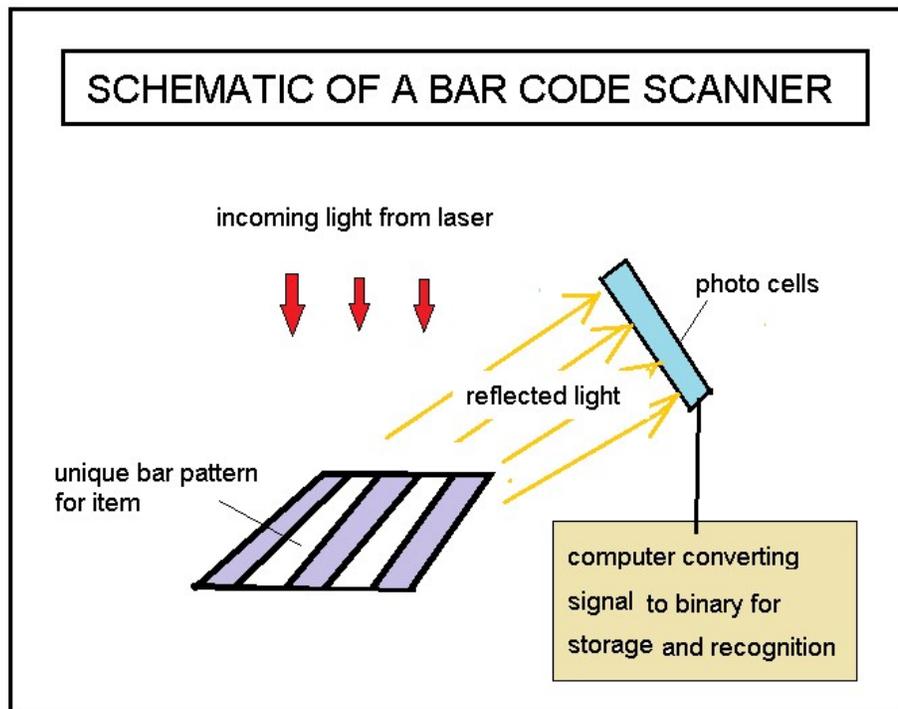
Note that the numbers below the bars are ignored by the computer but are handy for a checkout person wishing to verify a UPC configuration.

A few more bar codes, taken off of some items in my pantry are-

0 70330 50606 0	for a small bottle of Pic white-out
0 51000 01251 7	for Campbell's tomato soup
0 76800 00691 7	bag of Lenders bagels
0 45300 00549 2	creamy Peter Pan peanut butter
0 70404 00820 9	bottle of Pompein olive oil

As seen, each of these items has its own number pattern which is convertible to its own unique white-black line configuration.

Having shown how each item has its own unique bar code, we next go on to see how these are handled by a computer. The basic procedure for achieving this is a scanner which uses the difference in reflection between a white and black line to energize an array of photoelectric cells with charges which are then converted into binary computer language and stored and transmitted. Here is a diagram of the bar scan setup-



It is the difference in charge density at the photo cells between white and black stripe reflections which makes the process work. White stripes means we have strong reflection while black yields weak reflection.

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October 28, 2021  
Gainesville, Florida