DRAFT

GROCERY INDUSTRY UPC SYMBOL

SYMBOL SPECIFICATION

RCA II SYMBOL

3/23/73

#7

KEY FEATURES OF RCA II UNIVERSAL PRODUCT CODE SYMBOL

Increased Printing Tolerances	Using this new symbol tolerance, ranges of from ± .001" to ± .010" will be permitted based upon the size of the printed symbol.
Size Variations	This symbol permits variations in physical size of the symbol by allowing single-bit variations between .009" and .030". This variable-sized symbol will, therefore, be adaptable to the wide range of printing capabilities available to the industry.
Light Pen Capability	Use of the RCA II symbol will permit scanning by simple light-pen type systems.
UPC Expandability	The RCA II UPC symbol has the inherent capability of representing from one to as many as thirty decimal digits. This will provide ample allowance for accomodation with numeric product codes adopted by other retailing industries.
Most Efficient Code	Because the coding system for the RCA II symbol requires the use of only 70 bits of information to perform its function, it is the most efficient code available to the committee.
In-Store Labeling	The code structure of the new symbol can be adapted to the elimination of leading and trailing zeroes. The abbreviated three-digit versions of the UPC which would result from this could be used to identify up to 999 high velocity items in each store. Small three-digit symbols could be applied to these high volume items by means of high-speed, hand-held, label guns at store level to provide a low cost symbol application method to bridge the gap between initial scanner system installations and cost-effective levels of source symbol marking.

Truncated Symbol	Where space is limited and where there is an obvious natural orientation of the product to the scanner, a truncated version of the symbol, representing a radius of the symbol including its center, may be used.
Bar-type Version	Bar-type versions of the RCA II symbol can also be used to adjust to product space limitations, as in the case of the truncated symbol version described above.
Error Detection	The new symbol incorporates a check digit utilizing the Module 10 error detection method which provides accurate error detection.
Improved Space Utilization	Use of a half bullseye provides more efficient utilization of packaging real estate.
Omnidirectionality	Because the symbol remains curvilinear, it retains its capability for omnidirectional scanning.

1.0 INTRODUCTION

The purpose of this document is to provide the members of the grocery industry with the general and technical information necessary to evaluate the RCA II Universal Product Code symbol proposed by RCA Corporation for use by the industry in the implementation of supermarket front-end automation.

The symbol design and printing specifications included herein are designed to meet the guidelines established by the Grocery Industry Ad Hoc Committee on the Universal Product Code, and those established by the Symbol Standardization Subcommittee.

The RCA symbol is the result of more than seven years of research and development in the area of supermarket fron-end automation. This R & D effort has been conducted with the assistance and cooperation of a great number of companies and individuals in all areas of the grocery industry. RCA would like to take this opportunity to thank all those who have given so generously of their time and knowledge in this effort.

The materials that follow are broken down into sections covering the major elements to be considered in choosing an industry symbol. They are:

* Symbol Description
* Dimensional Requirements
* Optical Requirements
* Code Descriptions

* Printing Considerations
* Symbol Location
* Application Methods
* Quality Control Methods

2.0 SYMBOL DESCRIPTION

2.1 General

The RCA II Universal Product Code symbol being proposed by RCA consists of a "machine-readable" pattern of binarily encoded concentric half-bands and a "human-readable" 10 digit number. (Figure 1) This half-bullseye pattern is a binary equivalent of the 10 digit number and can be read by either a fixed-slot scanner or a hand-held light pen.

The intent of the symbol is to accurately and easily encode grocery merchandise, permitting the use of an automated checkout system in which the current price of the commodity and other information are retrieved from a storage file and transmitted to the checkstand. (See Figure 2).

The symbol is essentially an omni-directional bar code, i.e., it can be read in any orientation from the outside to inside or inside to outside. It has the inherent advantage of accuracy since internal checks verify the correctness of the code. Omnidirectionality and scanning accuracy of a UPC symbol are directly related to increased savings at the supermarket front end.

A major advantage of the symbol is that an infinite number of uniform size variations are permitted between the smallest size and 3.3 times

FIGURE 1

the smallest size. Since the allowable printing tolerance increases substantially with size, virtually any printing process can be used to generate the symbol without taking special precautions. We feel that this is a major advantage for the printing industry since tolerance has been their major concern.

Since only one scan of the symbol is required to read and verify the encoded data, the merchandise can be moved across a fixed-slot scanner at speeds up to 80 inches per second or can be read by a wand at speeds from 5 to 50 inches per second. Display of the retrieved price and printing of the price and other retrieved information on the sales slip at the checkstand is accomplished in as little as 1/3 of a second.

FIGURE 1 (equivalent of Figure 2) FIGURE 2 (equivalent of Figure 1)*

2.2 Variations (Composition)

In order to meet industry symbol requirements for differentiation between the various types of merchandise and transactions that are found in the supermarket environment, such as standard measure items, variable measure items, coupons, and items that could require long term compatibility with other commodity codes, the RCA symbol has been designed so that the basic symbol structure for each number can be modified four ways to permit this differentiation. As example of such a variation in symbol composition is provided in Figure 2.

FIGURE 2 (equivalent of Figure 3)

* The figure numbers in parentheses refer to the figures in the RCA I Specification.

2.3 Variations (Number Locations)

The 10-digit number represented by the symbol is normally located outside, and underneath the half-bullseye. However, it is possible to locate the numbers above, or above and below the symbol. (Illustrated in Figure 3). It is also possible to superimpose the number on the half-bullseye. If the number is superimposed it is necessary to print the number with an ink that is PMS Standard "Warm Red Transparent", or equivalent.

FIGURE 3 (equivalent of Figure 4)

2.4 Variations (Shape)

Although the preferred use of the symbol is in its full omni-directional half-bullseye form, there are, obviously, some products whose size and shape prohibit the use of the full symbol. In addition, there are other products that have dimensions that would require an obvious special orientation to the scanner in order to be read. Fortunately, since the RCA bullseye is essentially a bar-coded symbol, such products can use one of two partial symbol configurations, as described and illustrated below. However, it is recommended that these partial configurations be used after every effort has been made to utilize the full symbol. Note that any variation can be varied in size also, as was alluded to in section 2.1.

2.4.1 Truncated Version

One modification of the basic symbol which can be successfully used (if space is a problem and directional scanning is not) is depicted in Figures 4 and 5 below.

FIGURE 4 (equivalent to Figure 5) FIGURE 5 (equivalent to Figure 6)

The angle θ can assume any value up to 180°. Naturally, as θ increases, less orientation of the package is required.

2.4.2 Bar Symbol Version

A second modified version of the basic symbol is the parallel bar equivalent of the bullseye, as illustrated in Figure 6. This version has been designed for use in situations where it may prove to be economically or physically unfeasible to apply the symbol to the natural bottom, or top, of the product. As illustrated, when using this version, the length (perpendicular to the bars) of the symbol is the same as the symbol height. The width (parallel to the bars) may be any convenient dimension between 0.1" and 0.5".

This version of the symbol is particularily recommended for cans and bottles where side marking is highly desirable. An example of the use of this version of the symbol is shown in Figure 7.

FIGURE 6 (equivalent of Figure 7) FIGURE 7 (equivalent of Figure 8)

3.0 DIMENSIONAL REQUIREMENTS

3.1 Symbol Dimensions

The half-bullseye is summarized in Figure 8 and Chart I. The symbol consists of 70 concentric bands which extend slightly below the geometric center. As explained in 5.0, most of the bands may be either light or dark. Note that every dimension on the symbol is an integral multiple of the "basic" or smallest band width W. W can assume any

value from .009" ± .001" to .030" ± .010" inclusive. The RCA coding (see 5.0) is such that only the multiples shown in Figure 8 will appear on any given symbol. Note the overall dimensions of the symbol: 73W high x 140W wide.

The portion of the bands which lie below the diameter by an amount equal to 3W may be either curved or straight. Areas shown in Chart I presuppose that the bands are straight and are therefore maximum values.

Dimensions and tolerances for intermediate bandwidths may be obtained by interpolating between two adjacent points in Chart I.

The particular font style and location of the human-readable code is a function of the maximum area allocated to the symbol (half-bullseye plus digits) and the chosen size of the basic band width. Both may be adjusted accordingly, keeping in mind that the human-readable code must be easily discernable at arm's length.

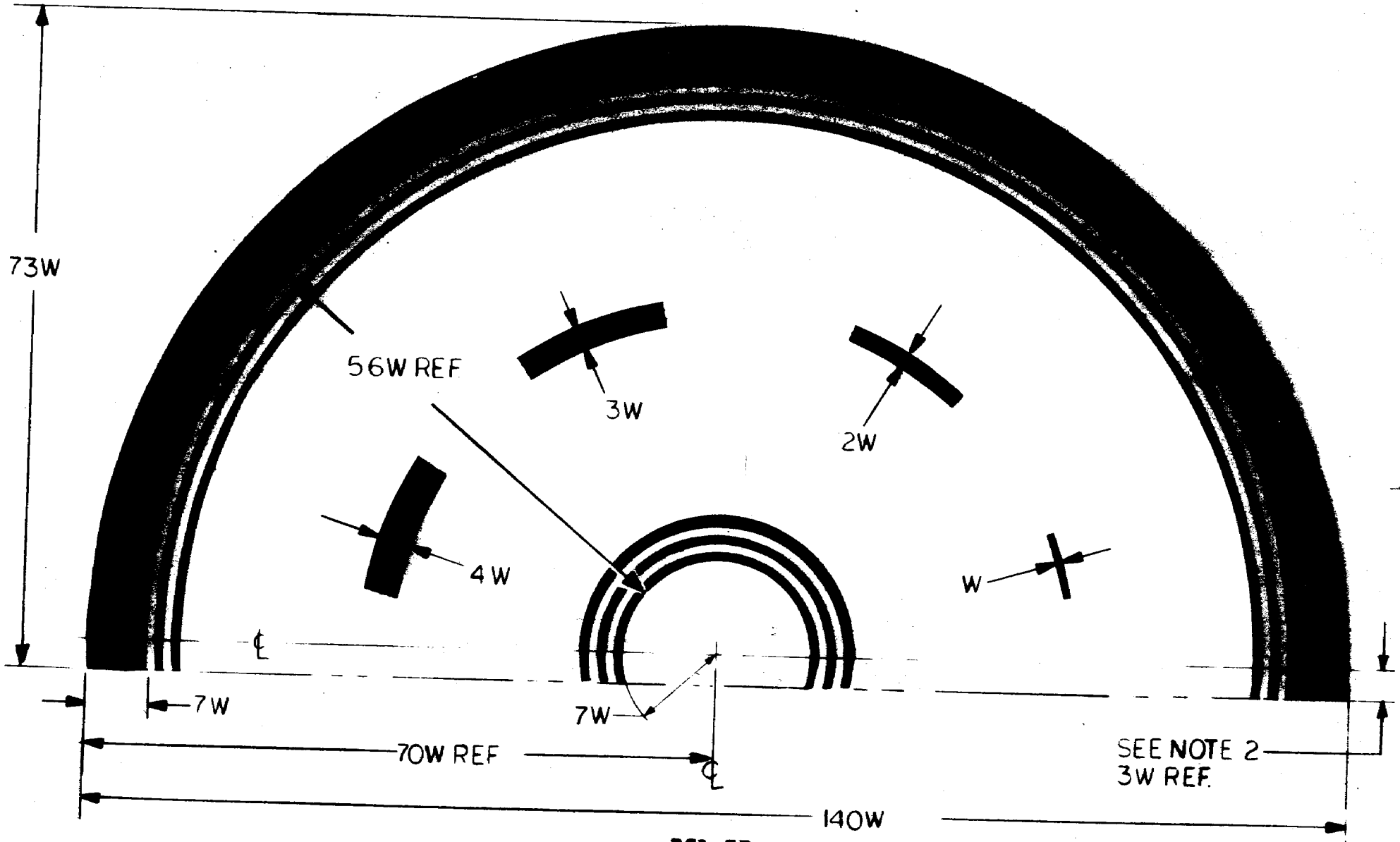
FIGURE 8 CHART I (equivalent to Figures 9 and 10)

3.2 Printing Quality Requirements

Print quality requirements are described by the factors below. Unless otherwise specified, all requirements pertain to any variation of the symbol. (size, composition, number, location, and shape)

3.2.1 Voids

Maximum dimension in any direction should not exceed .003". Within a dark band, no more than one void of the above size can be tolerated for each .005" of arc length.



RCA II
SYMBOL STRUCTURE

NOTES: 1) SEE CHART I FOR DIMENSIONS AND TOLERANCES.
2) BANDS IN THIS AREA MAY BE EITHER CURVED OR STRAIGHT.

FIGURE 8

RCA II - CHART I

SYMBOL DIMENSIONS AND TOLERANCES

I Basic Band Width (W)	II Double Band (2W)	III Triple Band (3W)	IV Quadruple Band (4W)	V Outer Band or Center Radius (7W)	VI Tolerance (columns I-IV)	VII Symbol Height (73W)	VIII Symbol Width (140W)	IX Symbol Area (in^2)
.009	.018	.027	.036	.063	±.001	.657	1.260	.657
.010	.020	.030	.040	.070	±.002	.730	1.400	.812
.011	.022	.033	.044	.077	±.003	.803	1.540	.982
.012	.024	.036	.048	.084	±.004	.876	1.680	1.168
.013	.026	.039	.052	.091	±.004	.949	1.820	1.372
.014	.028	.042	.056	.098	±.005	1.022	1.960	1.591
.015	.030	.045	.060	.105	±.005	1.095	2.100	1.826
.016	.032	.048	.064	.112	±.006	1.168	2.240	2.078
.017	.034	.051	.068	.119	±.006	1.241	2.380	2.345
.018	.036	.054	.072	.126	±.007	1.314	2.520	2.630
.019	.038	.057	.076	.133	±.007	1.387	2.660	2.931
.020	.040	.060	.080	.140	±.007	1.460	2.800	3.247
.021	.042	.063	.084	.147	±.008	1.533	2.940	3.579
.022	.044	.066	.088	.154	±.008	1.606	3.080	3.928
.023	.046	.069	.092	.161	±.008	1.679	3.220	4.294
.024	.048	.072	.096	.168	±.008	1.752	3.360	4.676
.025	.050	.075	.100	.175	±.009	1.825	3.500	5.073
.026	.052	.078	.104	.182	±.009	1.898	3.640	5.487
.027	.054	.081	.108	.189	±.009	1.971	3.780	5.917
.028	.056	.084	.112	.196	±.009	2.044	3.920	6.363
.029	.058	.087	.116	.203	±.010	2.117	4.060	6.826
.030	.060	.090	.120	.210	±.010	2.190	4.200	7.305

Note: 1) All dimensions are in inches
2) Tolerances for columns VII-IX are code dependant

3.2.2 Edge Roughness

Edge roughness can be specified by the peak-to-peak amplitude and minimum arc length of adjacent peaks and valleys. These specifications vary as the symbol changes size as summarized below:

Basic Band Width (nominal)	Maximum Peak-to-peak Amplitude	Maximum Arc length
.009 - .010	to be supplied	to be supplied
.011	.002	.005
.012 - .030	to be supplied	to be supplied

3.2.3 Edge Accuity

Any point from which a band width measurement is made should have a reflectance value which is at least 50% of the average reflectance for that band.

3.2.4 Ink and Dirt Spots

Maximum dimension in any direction should not exceed .003". Within a given band, no more than one ink or dirt spot of the above size can be tolerated for each .005" arc length. In addition, the human-readable number must be easily discernible.

3.2.5 Ink Film Uniformity

No restrictions, as long as optical requirements (see 4.0) are met.

3.2.6 Inclusions

Maximum dimension in any direction should not exceed .003". Within a

light band, no more than one inclusion of the above size can be tolerated for each .005" of arc length.

3.2.7 Show-Through

No restrictions, as long as optical requirements (see 4.0) are met.

3.2.8 Scuff and Scratch Resistance

The type of ink used, selection of substrate, symbol location, use of protective barrier, etc., should be such that, under normal handling (from printing level to store level), all optical and dimensional requirements of the symbol are maintained.

3.3 Other Physical Requirements

3.3.1 Symbol Embossment

Since the symbol is optically read on a fixed surface, the degree to which the printed image is depressed below, or raised above, the surface of the package is inconsequential, as long as all other requirements are met.

3.3.2 Symbol Surface Curvature

For the symbol to be read omnidirectionally, the radius of curvature of the surface at the half-bullseye portion of the symbol shall be greater than or equal to the value shown below. This radius applies to any section of symbol area and may be either cylindrical or spherical, concave or convex.

Basic Band Width (nominal)	Minimum Radius of Curvature
.009 - .010	to be supplied
$.012^{.011}$ - .030	$\frac{1.0}{\text{to be supplied}}$

3.3.3 Symbol Vertical Displacement

The maximum height of any portion of the symbol being scanned, above the counter surface, and the angle between the plane of the symbol and the plane of the scanner surface (tilt) when measured in the direction of the scanner slot shall not exceed the values listed below.

Basic Band Width (nominal)	Maximum Displacement	Maximum Tilt
.009" - .010"	to be supplied ---	
.011"	0.5"	15°
.012" - .030"	to be supplied ---	

4.0 OPTICAL REQUIREMENTS

4.1 Reflectivity

Contrast is defined as the difference between the diffuse reflectance of the light bands and the diffuse reflectance of the dark bands. Minimum value is 30%. Measurements should be made in accordance with section 9.0. Note that the background or light area may be the substrate as well as the light bands.

4.2 Substrate Reflectance

Optical properties of the substrate are important only if used as the background or "light" portion of the symbol. If this is the case, optical requirements are as listed above. By virtue of the design of the scanner optics, diffuse, rather than specular, reflectance must be controlled.

4.3 Barrier Restrictions

Any barrier such as a transparent film or a frost, stain or moisture

film is permitted, providing all symbol optical requirements are met.

4.4 Color Variations

4.4.1 General

The preferred colors for the dark and light bands are black and white, respectively, although almost any color combination that meets the required optical contrast may be used. (see Section 4.1)

Some typical background colors are whites, reds, and yellows; while some typical image colors are blacks, browns, greens and blues.

4.4.2 Special Properties of Red

Since the scanner employs a red light source most reds are recognized by the scanner as white. For this reason they should be avoided for the image bands. However, the special properties of reds can be advantageously used for overprinting the UPC number of the sumbol in situations where space does not permit printing the number below or above the bullseye, or its variations. In addition, these properties also make possible the use of red as a background color. An additional use of red could be as a deterrent to photocopy counterfeiting - for instance, by printing the center zone of the symbol red, or by using red for overprinting the UPC number, as noted above.

5.0 CODE DESCRIPTION

5.1 Code Objectives

The coding of the proposed RCA Universal Product Code symbol was specifically designed with the following goals in mind:

* To permit reading with either a fixed-slot or a light pen-type of scanner
* To be cost effective in terms of label making and scanning equipment requirements
* To provide immediate and completely effective error detection
* To provide an infinite number of uniform size variations between 1X and 3.3 X (approximately)
* To facilitate automated artwork generation
* To permit simple manual decoding of the symbol ring structures
* To facilitate etching of printing plates
* To provide compatibility with any length code by expanding the number of bands in modular fashion (see below).

5.2 Coding

The coding is best understood by breaking up the 70 semi-circular bands into discreet sections and describing each one. (Figure 9). All bands are numbered from the center to the outside. (Dark = 0 and Light = 1).