Digit to Code 128 Barcode Segment Converter

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Overview

- Manually dealing with large amounts of data is both time consuming and costly
- With the help of technology, people are able to cut cost and save time
- Invention of barcodes
  - A machine-readable code
  - A reliable and easier way to store, transfer, and process information

Application

Barcodes are widely used in various industries such as shopping, shipping, and for inventory control.

Code 128

CODE 128 is a computer friendly linear barcode that was developed in 1981 which can represent all 128 ASCII code characters.

Project objective:

Implement a binary to code 128 converter using logic gates

Variables

Input

The input number is represented in 4 bits (binary). This will serve as the 4 input variables.

Output

The output number is represented in 11 bits (binary). Each bit represents whether the block is shaded black or white for the bar according to the CODE 128 standard representation.

1 - Black || 0 - White

Sample

1 - Black

0 - White

INPUT OUTPUT

0000 

0001 

Design Methodology

Truth Table

i1	i2	i3	i4	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11
0	0	0	0	1	1	0	1	1	0	0	1	1	0	0
0	0	0	1	1	1	0	0	1	1	0	1	1	0	0
0	0	1	0	1	1	0	0	1	1	0	0	1	1	0
0	0	1	1	1	0	0	1	0	0	1	1	0	0	0
0	1	0	0	1	0	0	1	0	0	0	1	1	0	0
0	1	0	1	1	0	0	0	1	0	0	1	1	0	0
0	1	1	0	1	0	0	1	1	0	0	1	0	0	0
0	1	1	1	1	0	0	1	1	0	0	0	1	0	0
1	0	0	0	1	0	0	0	1	1	0	0	1	0	0
1	0	0	1	1	1	0	0	1	0	0	1	0	0	0
1	0	1	0	1	1	0	0	1	0	0	0	1	0	0
1	0	1	1	1	1	0	0	0	1	0	0	1	0	0
1	1	0	0	1	0	1	1	0	0	1	1	1	0	0
1	1	0	1	1	0	0	1	1	0	1	1	1	0	0
1	1	1	0	1	0	0	1	1	0	0	1	1	1	0
1	1	1	1	1	0	1	1	1	0	0	1	1	0	0

Boolean Functions and K-Maps

$b_1 = 1$

$b_2 = i_1'i_2'i_3' + i_2'i_3i_4' + i_1i_2'i_4$

$b_3 = i_1i_2i_3'i_4' + i_1i_2i_3i_4$

$b_4 = i_1'i_3'i_4' + i_1'i_3i_4 + i_2i_4' + i_1i_2$

$b_5 = i_2'i_3' + i_3i_4' + i_2i_4$

$b_6 = i_1'i_2'i_3'i_4 + i_1'i_2'i_3i_4' + i_1i_2'i_3'i_4' + i_1i_2'i_3i_4$

$b_7 = i_1'i_2'i_3i_4 + i_1i_2i_3'$

$b_8 = i_1'i_3' + i_1'i_2'i_4 + i_3'i_4 + i_2i_4' + i_1i_2$

$b_9 = i_1'i_3' + i_2'i_4' + i_3'i_4' + i_2i_4 + i_1i_3$

$b_{10} = i_1'i_2'i_3i_4' + i_1i_2i_3i_4'$

$b_{11} = 0$

$b_1 = 1$

i1, i2 \ i3, i4	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$b_2 = i_1'i_2'i_3' + i_2'i_3i_4' + i_1i_2'i_4$

i1, i2 \ i3, i4	00	01	11	10
00	1	1	0	1
01	0	0	0	0
11	0	0	0	0
10	0	1	1	1

$b_3 = i_1i_2i_3'i_4' + i_1i_2i_3i_4$

i1, i2 \ i3, i4	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	0	1	0
10	0	0	0	0

$b_4 = i_1'i_3'i_4' + i_1'i_3i_4 + i_2i_4' + i_1i_2$

i1, i2 \ i3, i4	00	01	11	10
00	1	0	1	0
01	1	0	1	1
11	1	1	1	1
10	0	0	0	0

$b_5 = i_2'i_3' + i_3i_4' + i_2i_4$

i1, i2 \ i3, i4	00	01	11	10
00	1	1	0	1
01	0	1	1	1
11	0	1	1	1
10	1	1	0	1

$b_6 = i_1'i_2'i_3'i_4 + i_1'i_2'i_3i_4' + i_1i_2'i_3'i_4' + i_1i_2'i_3i_4$

i1, i2 \ i3, i4	00	01	11	10
00	0	1	0	1
01	0	0	0	0
11	0	0	0	0
10	1	0	1	0

$b_7 = i_1'i_2'i_3i_4 + i_1i_2i_3'$

i1, i2 \ i3, i4	00	01	11	10
00	0	0	1	0
01	0	0	0	0
11	1	1	0	0
10	0	0	0	0

$b_8 = i_1'i_3' + i_1'i_2'i_4 + i_3'i_4 + i_2i_4' + i_1i_2$

i1, i2 \ i3, i4	00	01	11	10
00	1	1	1	0
01	1	1	0	1
11	1	1	1	1
10	0	1	0	0

$b_9 = i_1'i_3' + i_2'i_4' + i_3'i_4' + i_2i_4 + i_1i_3$

i1, i2 \ i3, i4	00	01	11	10
00	1	1	0	1
01	1	1	1	0
11	1	1	1	1
10	1	0	1	1

$b_{10} = i_1'i_2'i_3i_4' + i_1i_2i_3i_4'$

i1, i2 \ i3, i4	00	01	11	10
00	0	0	0	1
01	0	0	0	0
11	0	0	0	1
10	0	0	0	0

$b_{11} = 0$

i1, i2 \ i3, i4	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	0	0	0
10	0	0	0	0

Results and Conclusion

Results

Results Analysis

- Constants
  - b1 = 1
  - b11 = 0
- Pattern of Code 128
  - Always begin with black bar (1) and end with white bar (0)
- Constants and Patterns are reflected conversely

Challenges

- Finding a proper application that is relevant and unique
- Determining the proper input and output

Conclusion

Conclusion

- We can develop a system to convert numbers to a segment using combinational logic
  - Pattern of barcode segments

Recommendations

- Implement of larger binary inputs / implement full ASCII character set
- Try other barcode types
- Implement an application that can create a whole barcode
- Try barcode DECODER