Designing Segmented Display for Arabic Numerals

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Abstract: Humans use the decimal code to represent numbers. Digital electronic circuits in computers and calculators use mostly the binary code. Many other special codes are used in digital electronics to represent numbers, letters, punctuation marks and control characters. A common task of decoding from machine language to decimal numbers is encoding. A very common output device to encode English decimal numbers is the seven-segment display. In this study a 12-segment display is proposed for Arabic numeric characters display.

INTRODUCTION

The 7-segment display (Fig. 1a) is a very common output device used to display the decimal numbers (0-9). Twin 7-segment display is nothing but a joint of two 7-segment displays as Fig. 1b.

Segments and joint segments: In a 7 or 12-segment display each unit is known as segment in Fig. 1.

Segment display types: There are two types of displays used to display a segment in the any segment display system.

LED display: It is a common type of display consists of Light Emitting Diodes arranged as Fig. 3. Each segment in a LED that emits light when there is current through it. In Fig. 3a the common-anode arrangement requires the driving circuit to provide a low-level voltage in order to active a given segment. When a LOW is applied to a segment input, the LED is turned on and there is current through it. If Fig. 3b the common-cathode arrangement requires the driver to provide a high level voltage to activate a segment. When a HIGH is applied to a segment input, the LED is turned on and there is current through it.

LCD display: Another common type of display is the liquid crystal display (LCD). LCD operates by polarizing light so that a nonactivated segment reflects incident light and thus appears invisible against its background. An activated segment does not reflect incident light and thus appears dark. LCDs consumes much less power than LEDs but can't be seen in the dark, while LEDs can.
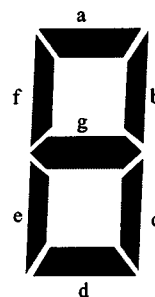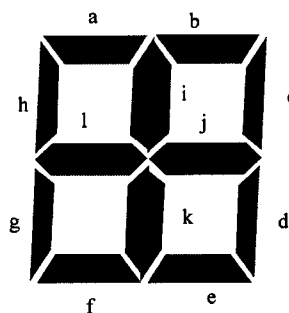

Fig. 1: 7-Segment display

Fig. 2: 12-Segment display

DESCRIPTION OF THE PROPOSED DISPLAY

The proposed display may be made up of 12 separate LED in a single package. The LEDs are oriented to form ?. In our proposed display we have an 13th LED to use for decimal point. The job of the decoder is to convert the 4-bit BCD code into a proposed segment code that will turn on the appropriate LED segments to display the correct decimal digit.

Table 1: Active and inactive segments for each decimal digits

Arabic digits	Equivalent english digits	Segments activated	Alternatives
	0	d, e, j, k	f, g, k, l or a, h, i, l or b,c, i, j
	1	i, k	c, d or h, g
	2	c, i, j, k	h, i, k, l
	3	c, g, h, i, j, l	
	4	a, c, g, h, i, j	
	5	d, e, f, g, i, j, l	
	6	c, d, i, j	h, i, k, l
	7	b, e, i, k	a, f, g, h
	8	b, c, d, i, k	a, g, h, i, k
	9	B, c, d, I, j	A, h, I, k, l

Table 2: Truth table for proposed segment logic

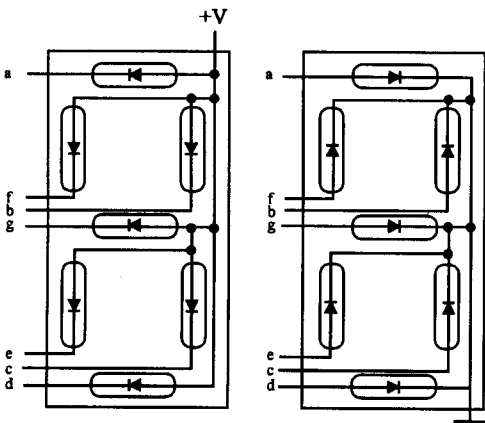| Digits	A_3	A_2	A_1	A_0	a	b	c	d	e	f	g	h	i	j	k	l
0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0
1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0
2	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0
3	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	1
4	0	1	0	0	1	0	1	0	0	0	1	1	1	1	0	0
5	0	1	0	1	0	0	0	1	1	1	1	0	1	1	0	1
6	0	1	1	0	0	0	1	1	0	0	0	0	1	1	0	0
7	0	1	1	1	0	1	0	0	1	0	0	0	1	0	1	0
8	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	0
9	1	0	0	1	0	1	1	1	0	0	0	0	1	1	0	0

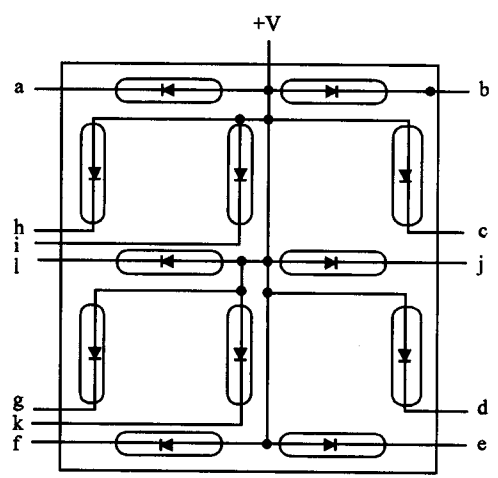Fig. 3: Common anode and common cathode LED displays

Fig. 4: Common Anode LED display for the proposed system

Common anode LED display for the our proposed system:
The physical layout of a 12- segment display is shown in Fig. 2. This figure shows that the anode of each LED (segment) is connected to the +5 V supply. Now to illuminate an LED, its cathode must be grounded through a series limiting register (Fig. 4). The value of the limiting resistor can be found by knowing that the voltage drop across an LED is 1.7 V and that is it takes approximately 10 mA to illuminate it. Therefore, R_{limit} = (5.0V-1.7V)/10mA = 330Ω.

Each segment in the proposed display unit may illuminate in the same way.

Common anode displays are active low (low enable) device because it takes a low to turn on (illuminate) a segment. Therefore the decoder IC used to derive a common anode LED must have active low outputs.

DESIGNING THE PROPOSED DISPLAY SYSTEM

The numeric designations for the 10 allowable decimal digits are shown in Fig .5.

For example if the segment i and k and i are lit then a decimal 1 of Arabic is displayed, on the other hand if a, b, c, d, e, f, g, h, j and l are no lit then the decimal 1 is displayed. By another way (c and d) or (g and h) can be used for display 1. But for better combination first one is chosen (it is discussed later).

Segment decoding logic: Each segment is used for various decimal digits. But no one segment is used for all
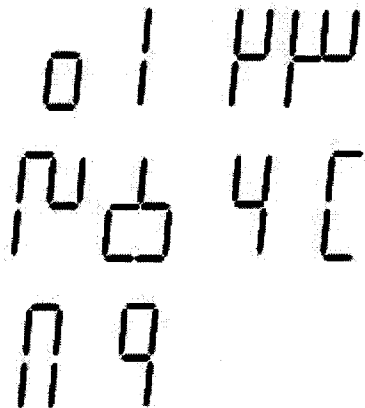
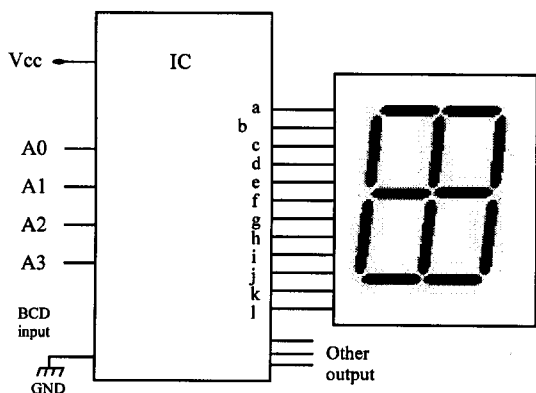Fig. 5: Segments layout for arabic numeric digits

Fig. 6: The segment logic block diagram

ten digits. Therefore each segments must be activate by its own decoding circuit that detects the occurrence of any of the numbers in which the segment is used. From Fig. 5 the segment that are required to be activated for each digit are determined and listed in Table 1.

Truth table for the segment logic: The segment decoding logic requires four Binary Coded Decimal (BCD) inputs and 12-segment outputs, one of each segment (or joint segment) in the display as indicated in the block diagram of Fig. 6. The multiple output truth table is shown in Table 2. A 1 in the segment output columns of the table indicates an activated segment.

Since the DCD code does not includes the binary values 1010, 1011, 1100, 1101,1110 and 1111 these combinations will never appear on the inputs and therefore be treated as dont care (x) conditions to analyzed while minimizing the logic circuits. To conform to the practice of most IC manufacturers, A_0 represents the least significant bit and A_3 represent the most significant bit in the application.

Boolean expression for the segment logic: From the Truth Table 2 a standard sum of Product (SOP) of all segments are as follows:

The minimum implementation of segment logic using k-map: We obtained the minimum SOP expression for all segments as under using karanagh map (k-map):
a $= \Sigma(4)$ b $= \Sigma(7,8,9)$ c $= \Sigma(2,3,4,6,8,9)$ d $= \Sigma(0,5,6,8,9)$
e $= \Sigma(0,5,7)$ f $= \Sigma(5)$ g $= \Sigma(4,5,6)$ h $= \Sigma(3,4)$
i $= \Sigma(1,2,3,4,5,6,7,8,9)$ j $= \Sigma(0,2,3,4,5,6,9)$ k $= \Sigma(0,1,2,7,8)$
l $= \Sigma(3,5)$

CONCLUSIONS

In this study a brief description of Arabic numerals representation in the LED display is described. It is also analyzed that in the seven-segment display of English digit representation the Arabic digits may also possible to represent. Although the digits 0, 2, 3, 5, 6, 8 and 9 are in carved shape and 1, 4 and 7 are in straight shape in English but in seven-segment representation every digit follows the digitized shape (all digits bound in a upper, lower, left and right margin) and thus the actual shape of some digits are changed from carved shape to the straight forward shape. If the strategy of seven-segment is followed it is also possible to represent the Arabic numerals in seven-segment format (except the 3 in Arabic). Thus the joint seven-segment (twelve segment) is proposed. That may be implemented to use in industrial purpose.

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