Digital Design through Pygmy

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Contents

Abstract—This document shows how to use the pygmy to design a decade counter using a finite state machine (FSM).

1 Software

All codes in this document are available at the following links.

https://github.com/gadepall/vaman/tree/master/arm/codes/decoders
https://github.com/gadepall/vaman/tree/master/arm/codes/fsm

2 Setup

2.1. Execute Table 2.1.1 using the pygmy and a seven segment display.
Solution: The outputs a, b, c, d, e, f, g in Table 2.1.1 are expressed in terms of the inputs A, B, C, D through the following equations.

$$a = AB'C'D' + A'B'CD' \tag{2.1.1}$$

$$b = AB'CD' + A'BCD' \tag{2.1.2}$$

$$c = D'C'BA' \tag{2.1.3}$$

$$d = AB'C'D' + A'B'CD' + ABCD' + AB'C'D \tag{2.1.4}$$

$$e = AB'C'D' + ABC'D' + A'B'CD' + AB'CD' + ABCD' + AB'C'D \tag{2.1.5}$$

$$f = AB'C'D' + A'BC'D' + ABC'D' + ABCD' \tag{2.1.6}$$

$$g = A'B'C'D' + AB'C'D' + ABCD' \tag{2.1.7}$$

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D	C	B	A	a	b	c	d	e	f	g	Decimal
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	0	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	1	1	0	0	9

TABLE 2.1.1: Truth table for the display decoder

Z	Y	X	W	D	C	B	A
0	0	0	0	0	0	0	1
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	1
0	0	1	1	0	1	0	0
0	1	0	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0

TABLE 2.2.1: Truth table for the incrementing decoder

Now execute the following code.

codes/decoders/dispdec/main.c

For different values of A, B, C, D, execute the above code to verify Table 2.1.1.

2.2. Table 2.2.1 shows the logic for the incrementing decoder. Express A, B, C, D in terms of W, X, Y, Z.
Solution: The desired expressions are

available below.

$$A = W'X'Y'Z' + W'XY'Z' + W'X'YZ' + W'XYZ' + W'X'Y'Z \quad (2.2.1)$$

$$B = WX'Y'Z' + W'XY'Z' + WX'YZ' + W'XYZ' \quad (2.2.2)$$

$$C = WXY'Z' + W'X'YZ' + WX'YZ' + W'XYZ' \quad (2.2.3)$$

$$D = WXYZ' + W'X'Y'Z \quad (2.2.4)$$

Execute the following code. You should see the next number displayed.

codes/decoders/incdec/main.c

2.3. Fig. 2.3.2 shows the pin diagram for the pygmy. Connect the pins in bank J5 to the seven segment display using Fig. 2.3.1 and Table 2.3.1. Do not forget to put a resistor between COM and 3.3V. Then execute the following code

codes/fsm/dispdec/main.c

Display	Pygmy
a	IO_4
b	IO_5
c	IO_6
d	IO_7
e	IO_8
f	IO_10
g	IO_11
COM	3.3 V

Input Variable	Pin
W	IO_28
X	IO_23
Y	IO_31
Z	IO_12

TABLE 2.3.1: Pin connection between the pygmy and seven segment display

2.4. Modify the above code to obtain a decade counter.

3 Decade Counter

3.1. Use the pygmy to implement all the decoders in Fig. 3.1.1. Implement the delay using a flip flop. This is an example of an FSM which is implemented using a sequential circuit.

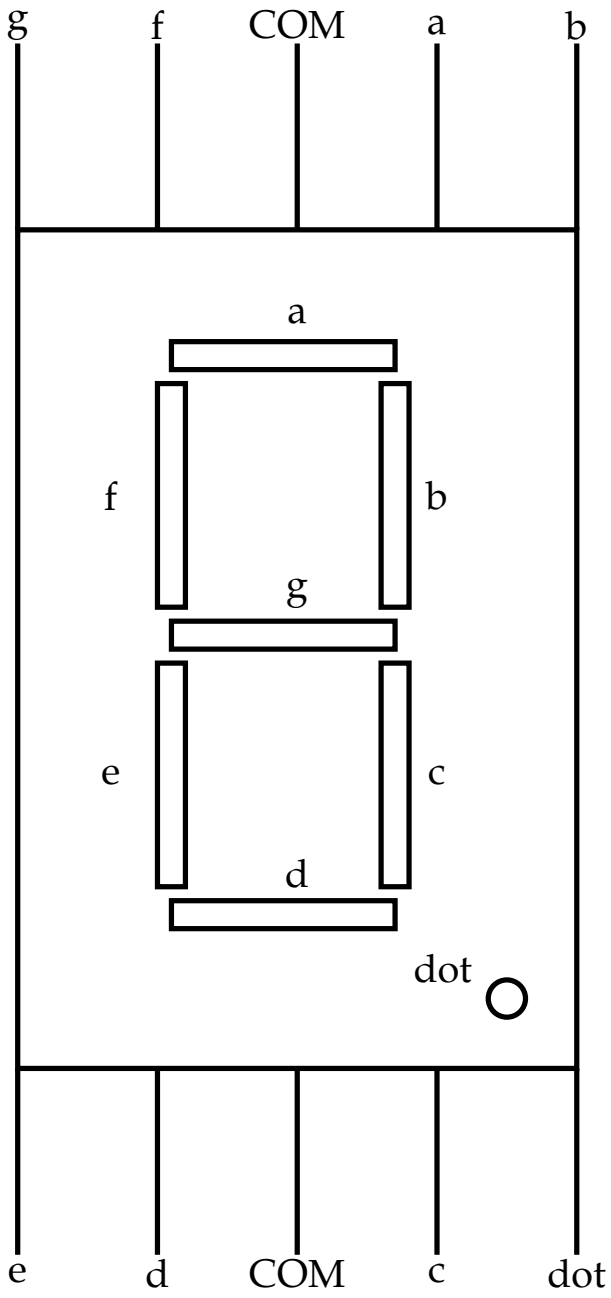

Fig. 2.3.1: Seven segment display.

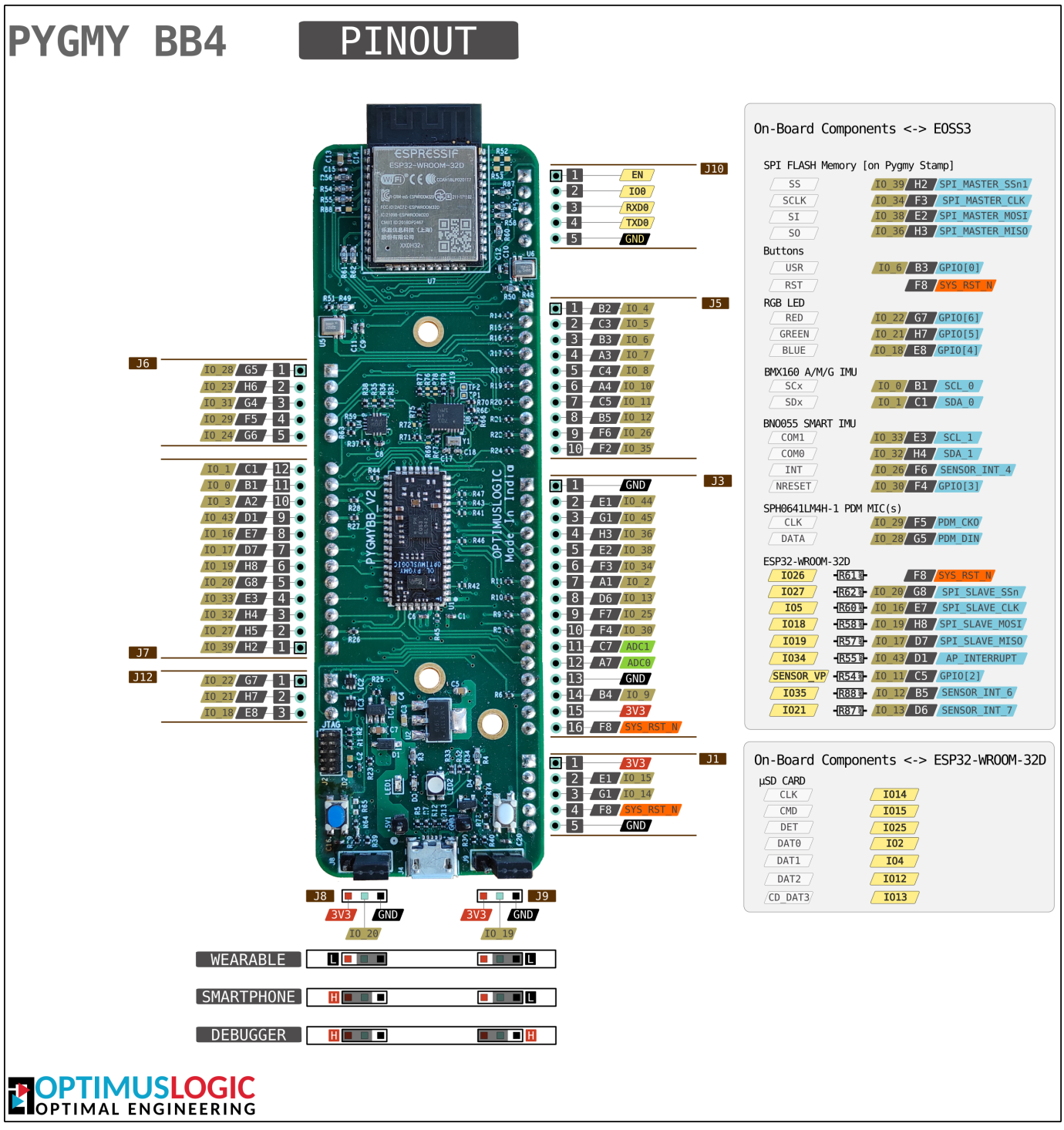

Fig. 2.3.2: Pin diagram

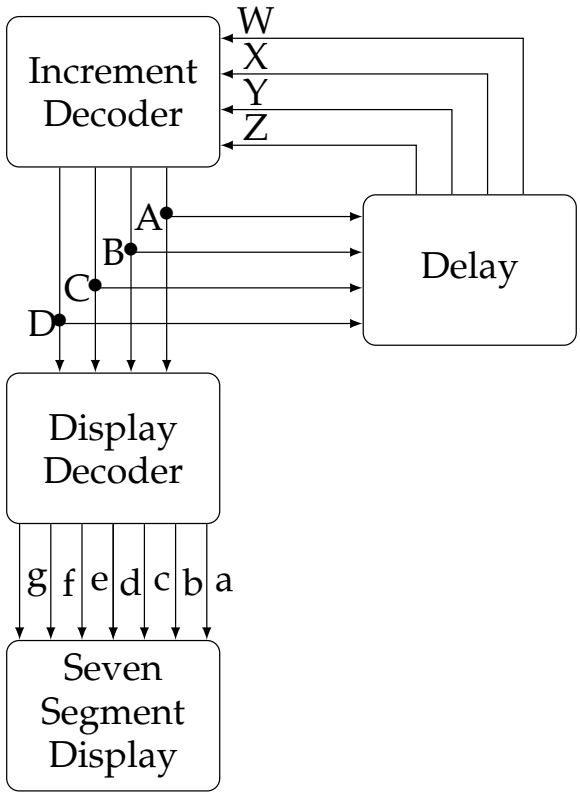

Fig. 3.1.1: Block diagram of a decade counter.