

Digital Design through Vaman

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Contents

- 1 Software
- 2 Setup
- 3 Decade Counter

- 1
- 1
- 2

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

Abstract—In this document we show how to design a decade counter using Vaman and boolean logic.

TABLE 2.1.1: Pin connections between Vaman and the display.

1 Software

All codes used in this manual are available at the following link.

<https://github.com/gadepall/vaman/tree/master/fpga/boolean/codes>

2 Setup

2.1. Fig. 2.1.2 shows the pin diagram for the Vaman. Using the bank J5, connect the pins of the seven segment display in Fig. 2.1.1 to the Vaman according to Table 2.1.1. Make sure that the COM pin is connected to 3.3V through a resistor.

2.2. Implement Table 2.2.1 using the Vaman and the display.

Solution: In Table 2.2.1, the output vari-

ables a, b, c, d, e, f, g can be expressed in terms of the input variables W, X, Y, Z as

$$a = WX'Y'Z' + W'X'YZ' \quad (2.2.1)$$

$$b = WX'YZ' + W'XYZ' \quad (2.2.2)$$

$$c = Z'Y'XW' \quad (2.2.3)$$

$$d = WX'Y'Z' + W'X'YZ' + WXYZ' + WX'Y'Z \quad (2.2.4)$$

$$e = WX'Y'Z' + WXY'Z' + W'X'YZ' + WX'YZ' + WXYZ' + WX'Y'Z \quad (2.2.5)$$

$$f = WX'Y'Z' + W'XY'Z' + WXY'Z' + WXYZ' \quad (2.2.6)$$

$$g = W'X'Y'Z' + WX'Y'Z' + WXYZ' \quad (2.2.7)$$

Execute the following program.

```
codes/decoders/dispdec.v
codes/decoders/Vaman.pcf
```

Connect W, X, Y, Z to GND. For different values of the input variables, verify the output in on the display using Table 2.2.1.

2.3. Table 2.3.1 describes the properties of the incrementing decoder. Using Boolean logic, express A, B, C, D in terms of W, X, Y, Z . Subsequently, implement this decoder by implementing the the expressions so obtained in the Vaman using verilog.

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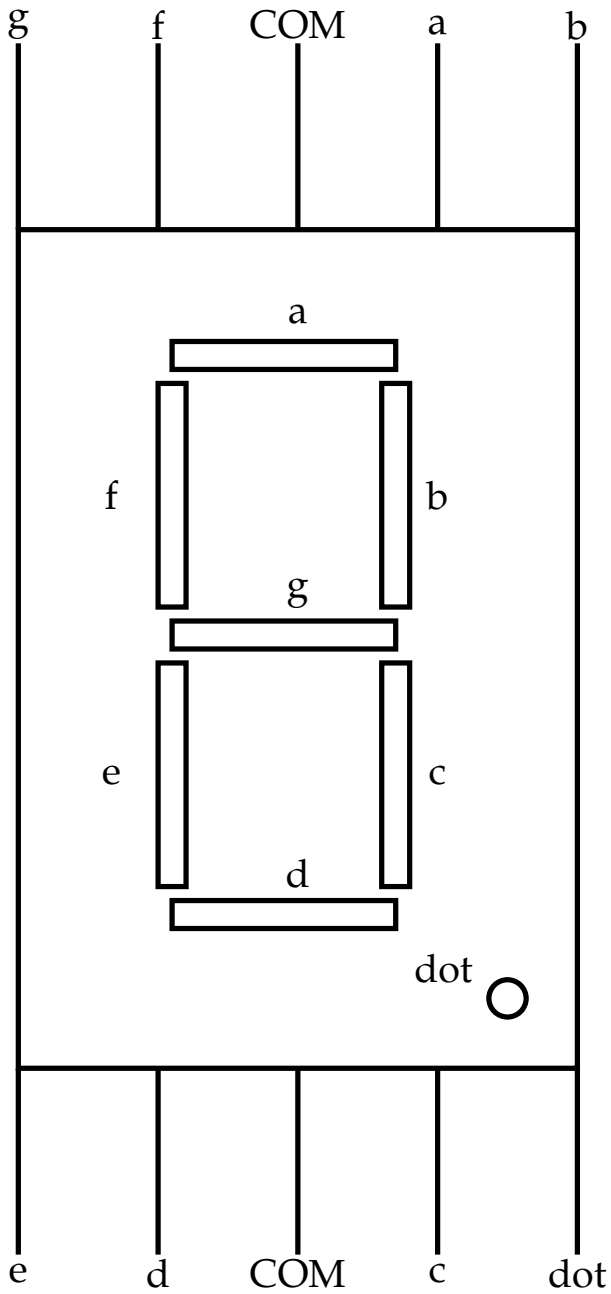


Fig. 2.1.1: Seven segment display

Z	Y	X	W	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 2.2.1: 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 2.3.1: Truth table for the incrementing decoder.

Execute the following code. The next number should be displayed.

```
codes/decoders/incdec.v
```

Solution: The following equations contain the desired expressions.

$$A = W'X'Y'Z' + W'XY'Z' + W'X'YZ' + W'XYZ' + W'X'Y'Z \quad (2.3.1)$$

$$B = WX'Y'Z' + W'XY'Z' + WX'YZ' + W'XYZ' \quad (2.3.2)$$

$$C = WXY'Z' + W'X'YZ' + WX'YZ' + W'XYZ' \quad (2.3.3)$$

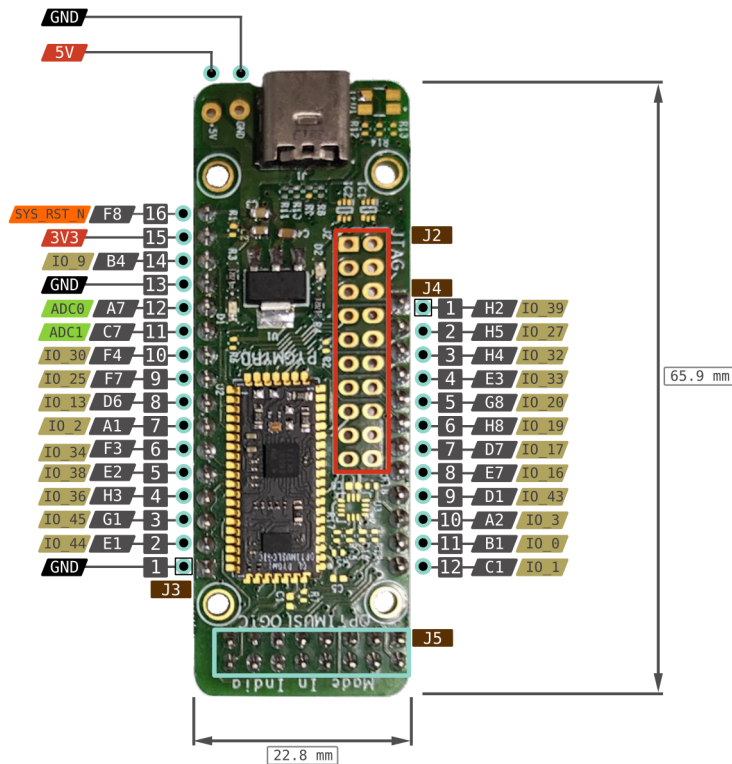
$$D = WXYZ' + W'X'Y'Z \quad (2.3.4)$$

3 Decade Counter

3.1. Using Fig. 3.1.1 and modifying the code in Problem 2.3, design the decade counter.

3.2. Design and implement the down counter.

PYGMY BB v1 PINOUT



- Reset
- Power
- GND
- IO/Pad Number
- Physical Pin/Ball
- Analog Input
- Pin Function(s)
- Component Pin
- Board Header Pin

On-Board Components

SPI FLASH Memory [on Pygmy Stamp]

SS	IO 39/ H2	SPI MASTER SSn1
SCLK	IO 34/ F3	SPI MASTER_CLK
SI	IO 38/ E2	SPI MASTER_MOSI
SO	IO 36/ H3	SPI MASTER_MISO

Buttons

USR	IO 6/ B3	GPIO[0]
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RGB LED

RED	IO 22/ G7	GPIO[6]
GREEN	IO 21/ H7	GPIO[5]
BLUE	IO 18/ E8	GPIO[4]

BMI160 ACCEL + GYRO

SCx	IO 0/ B1	SCL_0
SDx	IO 1/ C1	SDA_0

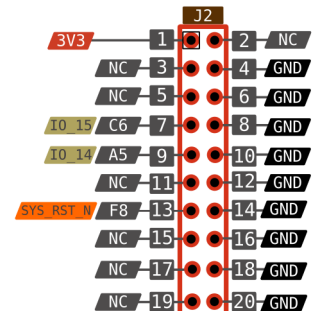
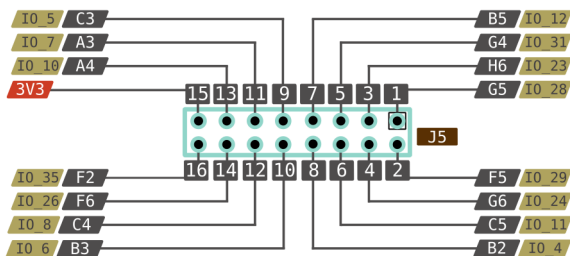


Fig. 2.1.2: Pin diagram

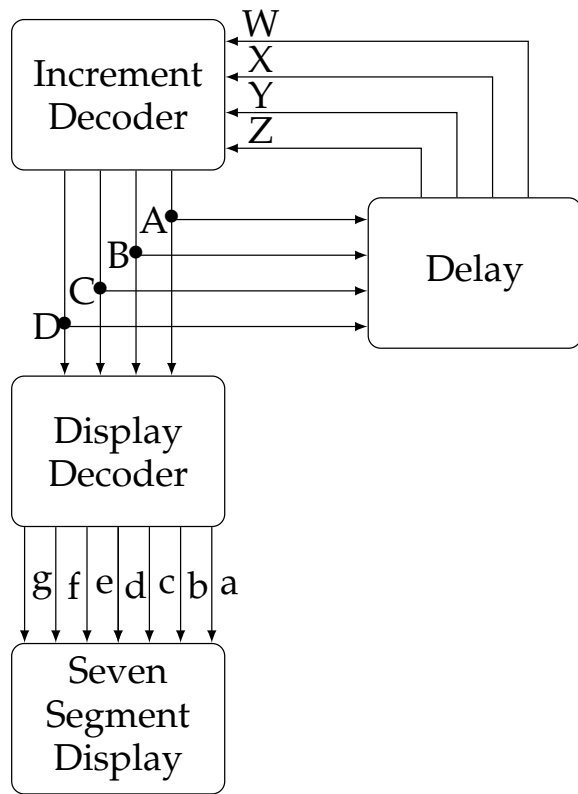


Fig. 3.1.1: Block diagram of the decade counter.