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Final Specification

History- Change log

10-11-2020	Document syntax created
14-11-2020	Added functional specification
24-11-2020	Block diagram added to report
05-12-2020	More blocks added
05-12-2020	More blocks diagrams added and description added
20-12-2020	FSM added to design
28-12-2020	Restructed the FSM
06-01-2021	Created the test benches
20-01-2021	Created a gitHub Respository and added all the files

Contents

Chapter 1

Requirements

Table 1.1: Functional Requirements

Requirement	ID	Importance	Verifiable	Description	Rewards
Gen.: persons	G01	High	VHDL-TB	The number of person in a room must be counted	none .
Gen.: max	G02	High	VHDL-TB	The number of person in a room should not exceed a certain limit	none
Gen.: only one person	G03	High	VHDL-TB	Only one person can either enter or exit the room	none
Gen.: Three light sensors	G04	Medium	VHDL-TB	There are three light curtains to track the direction and number of persons	To confirm that he either enters or exits the door
LED:green	LED01	High	Testbench	The maximum not reached	none
LED:red	LED02	High	Testbench	The maximum reached	none

Chapter 2

Product Overview

Because of COVID-19 restrictions, the number of persons gathered in a room must not exceed a maximal value.

This maximum value ranges from 1 to X_{max}. It is assumed that , there is only one doorway to enter and exit the room.Along the doorway , there are 3 LED light curtains to detect the number and motion of the people going in and out of the room.

Unique acoustic sound signal should be produced to identify the event and this events with a unique time stamp must be propagated into a PC using RS232-Interface.This is done with the help of 3 sensors. We have to check if the number of person in the room is equal to our maximal value X_{max} . If X_{max} is not reached, a green LED should be switched on . The green LED is switched off and a red LED is turned on when the number of people is equal to our maximal value .

This events along with the number of people at all time stamp is sent to the PC using a serial interface.

2.1 Top level view

The Application Specific Integrated Circuit should identify if a person enters or leaves the room. A three wire interface is used to transfer the events and the number of people into the **IC_S4**.

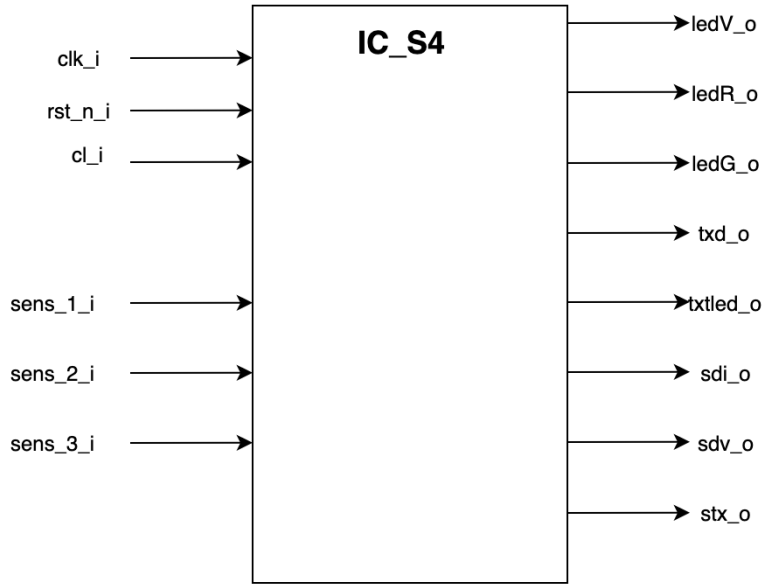

Figure 2.1: IC_S4 top view

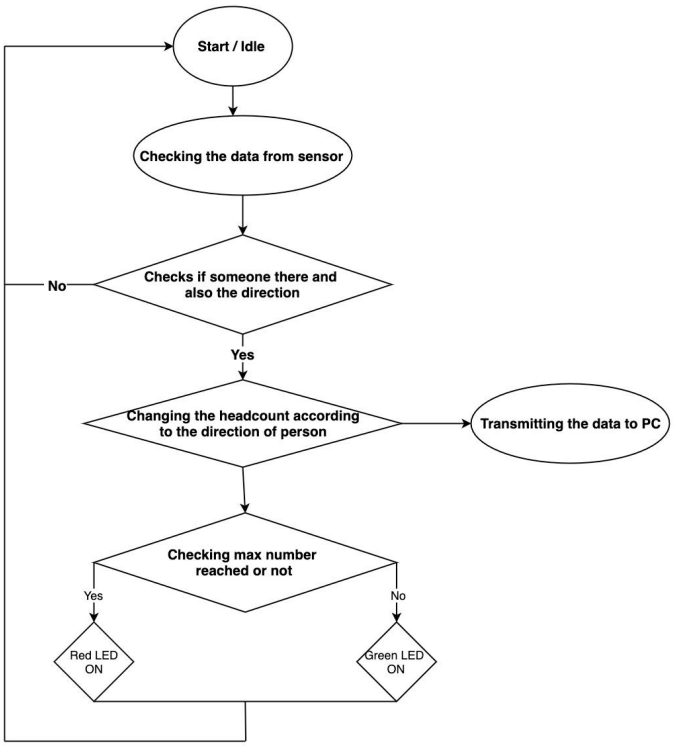

Figure 2.2: Flow Chart

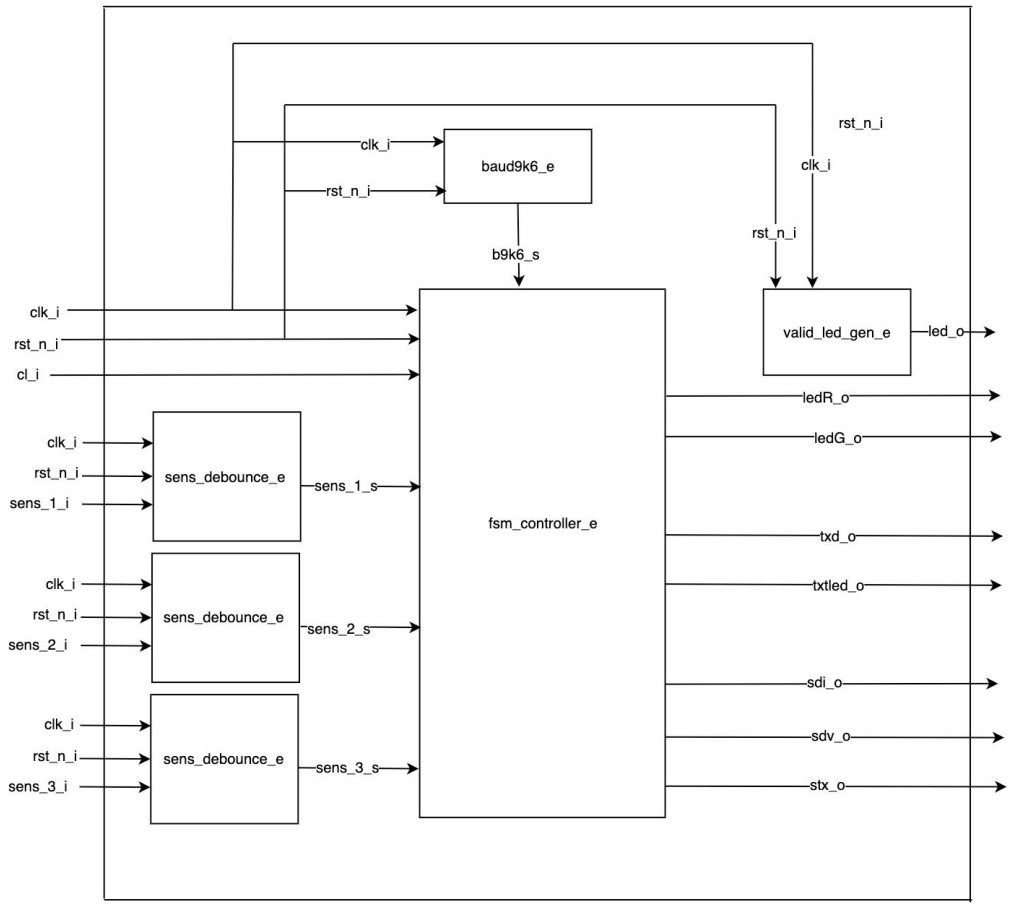

Figure 2.3: toplevel block diagram

Table 2.1: top level i/o

Pin	Direction	Width	Definition
cl_i	in	1	clears counter,active hight
clk_i	in	1	System clock with a freq of 12MHz
ledG_o	out	1	It activates a green LED,active high, the room is not full.
ledR_o	out	1	It activates a red LED,active high, the room is full.
ledV_o	out	1	heart beat led
rst_n_i	in	1	System reset, active low
sdi_o	out	1	Serial data interface to S3:serial data out
sdv_o	out	1	Serial data interface to S3:serial data valid
sens_1_i	in	1	light sensor 1 ,active high
sens_2_i	in	1	light sensor 2 ,active high
sens_3_i	in	1	light sensor 3 ,active high
stx_o	out	1	Serial data interface to S3:serial transfer valid
txd_o	out	1	A UART transmit serial data stream
txtled_0	out	1	shows that UART srunning, it activates a led , Active high.

Table 2.2: signals

signal	width	source	target	explanation
ledG_s	1	fsm_controller	ledG_o	signal to turn on the green LED
ledR_s	1	fsm_controller	ledR_o	signal to turn on the red LED
ledV_s	1	fsm_controller	ledV_o	signal to turn on the one second LED
per_cnt_s	10	fsm_controller	fsm_controller	no of people in the room
txd_cnt_s	10	fsm_controller	fsm_controller	storing the value of per_cnt_max
txd_reg_s	10	fsm_controller	fsm_controller	It contains the data from the sensor
b9k6_s	1	b9k6	fsm_controller	it indicates the baud rate
txd_s	1	fsm_controller	fsm_controller	it starts the UART transmission
end_stop_s	1	fsm_controller	fsm_controller	it ends the UART transmission
sens_1_s	1	sens_debounce_e	fsm_controller	signal from the first sensor
sens_2_s	1	sens_debounce_e	fsm_controller	signal from the second sensor
sens_3_s	1	sens_debounce_e	fsm_controller	signal from the third sensor

Chapter 3

Architecture Concepts

In this project we used the internal clock of the MAX10 FPGA which runs at frequency of 12MHz. Also we use the rising edge of our clock to trigger the all the signals.

In this project, we have a reset, which is active High. An active low is required to reset the whole process.

In the project, we use Finite state machine concept to identify the direction of person and to count the number of persons.

In this project, we use an RS-232 serial communication device which transmit the headcount including a +,- or ! sign to an external PC.The data transmission is also controlled by FSM.

Chapter 4

Controller Fsm

Table 4.1: FSM of the controller

Pin	Direction	Width	Definition
cl_i	in	1	clears counter,active hight
clk_i	in	1	System clock with a freq of 12MHz
ledG_o	out	1	It activates a green LED,active high, the room is not full.
ledR_o	out	1	It activates a red LED,active high.it,the room is full.
ledV_o	out	1	heart beat led
rst_n_i	in	1	System reset, active low
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sens_1_i	in	1	light sensor 1 ,active high
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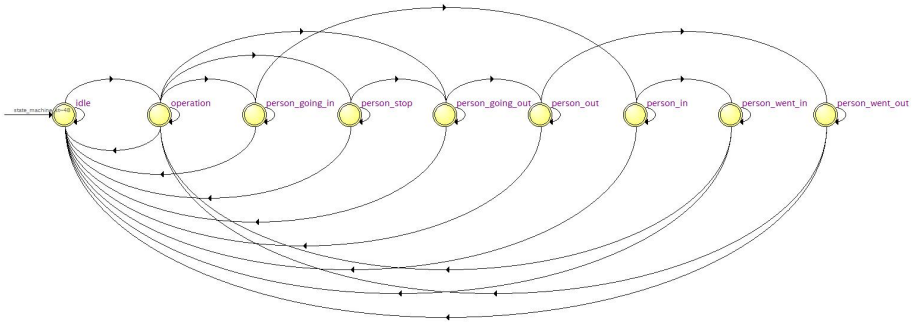

Figure 4.1: States of the FSM controller

The states of the controller fsm are ;

idle() : It is the initial state . All values are set to initial values.

operation : The state is changed into operation , as soon as a sensor gives a signal . In operation, the sensor which is activated will be checked and the state is changed.If the first sensor is activated , the state is changed to ” person_going_in”. And if the third sensor is activated , the state is changed to ”person_going_out”. The total number of people is checked with the maximal value. If the number of people reaches the maximum value , the state is changed to person_stop. The green LED is turned on .

person_going_in : The sensors are checked . If the second sensor is active , it means that a person is trying to go in . Then the state will be changed to ” person_in ” The green LED is turned of and the RED LED is turned on .

person_in :The sensors are checked . If the third sensor is active , it means that a person went in. So the state will be changed to ” person_went_in ” .

person_went_in :The state is changed back to ” operation ” , as we can confirm that a person went in. The red LED is turned of and the green LED is turned on.One is added to the total number of people(counter value). This counter value along with the + signal is transferred into the computer. The state is changed to operation .

person_going_out : The sensors are checked . If the second sensor is active , it means that a person is trying to go out . Then the state will be changed to ” person_out ”The green LED is turned of and the RED LED is turned on .

person_out :The sensors are checked . If the third sensor is active , it means that a person went out. So the state will be changed to ” person_went_out ”.

person_went_out :The state is changed back to ” operation ” , as we can confirm that a person went out. The red LED is turned of and the green LED is turned on. One is subtracted from the total number of people(counter value).This counter value along with the’-’signal is transferred to the compute. The state is changed to operation.

person_stop : A red LED is turned on .The sensors are checked. If the third sensor is active, the state will be changed to ”person_going_out .

If the clear signal is activated during any states, the state is changed back to idle. Every values will be set to initial values.

Chapter 5

Peripherals

5.1 Sensor debounce

(sens_debounce_e)

As we are using push buttons instead of sensors , we need to synchronise it the clock. So when a push button is pressed, the sens_debounce_s will synchronise it with the clock.

Table 5.1: sens_debounce_e

Pin	Direction	Width	Remarks
clk_i	in	1	System clock
rst_n_i	in	1	system reset
p_b_i	in	1	Push button input
sens_o	out	1	debounsed output

5.2 Valid LED Generator

(valid_led_gen_e)

To check weather it is working , we implement an LED which blinks on each second like that of a heart beat .

Table 5.2: valid_led_gen_e

Pin	Direction	Width	Remarks
clk_i	in	1	System clock
rst_n_i	in	1	system reset
led_o	out	1	activates the LED, active high

5.3 Baud rate

(baud9k6_e)

Divides the clock by 9600 and sends data every time when the remainder is 0 .

Table 5.3: baud9k6_e

Pin	Direction	Width	Remarks
clk_i	in	1	System clock
rst_n_i	in	1	system reset
en_o	out	1	baudrate signal