MICRO-CONTROLLER BASED OPTIMIZED TRAFFIC CONTROLLER

COURSE: MICROCONTROLLERS FOR MECHATRONICS

MECH 6621

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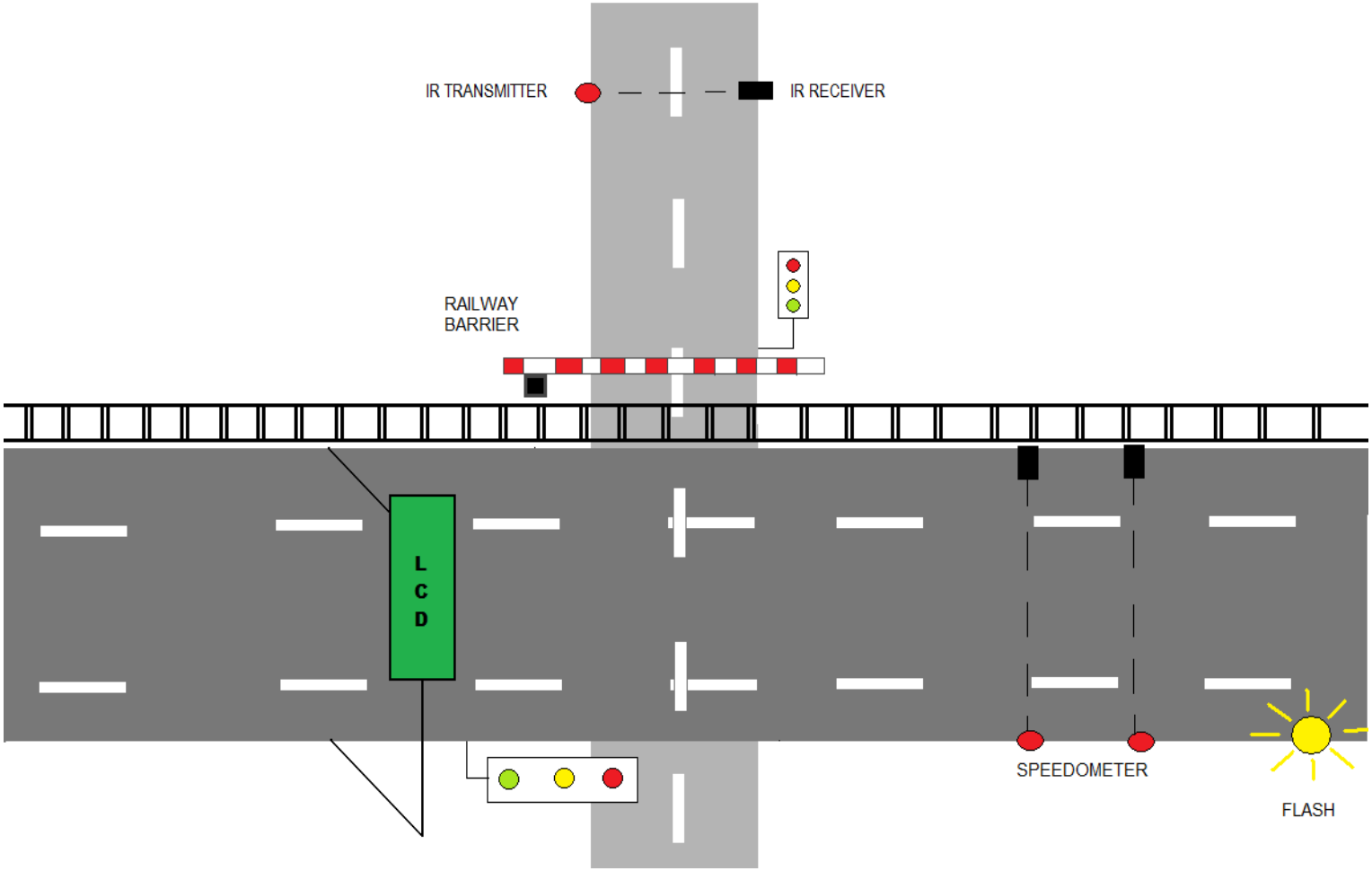
INTRODUCTION

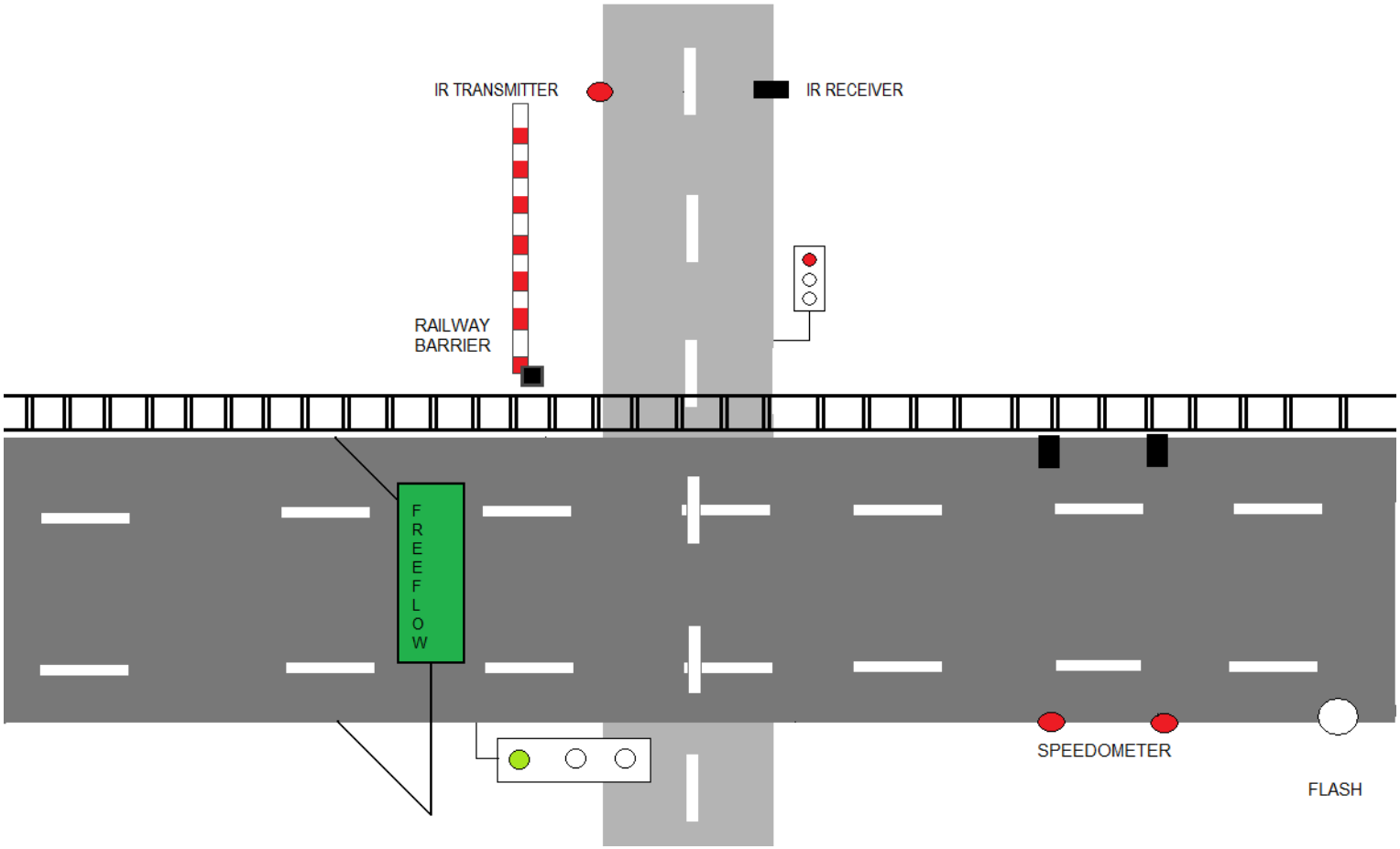
- The project aims to provide following functions:
  - A high priority is given to the highway traffic
  - Service the by-pass(or service road) according to its traffic (number of cars)
  - Notify the cars on highway for smooth or congested traffic, depending on traffic on service road on LCD
  - Check the speed of car on highway and flash the photo-radar if it exceeds speed limit
  - Control a railway barrier to stop traffic on service road when a train is coming regardless of other traffic conditions

LAYOUT


IR TRANSMITTER
IR RECEIVER
RAILWAY
BARRIER
L
C
D
SPEEDOMETER
FLASH

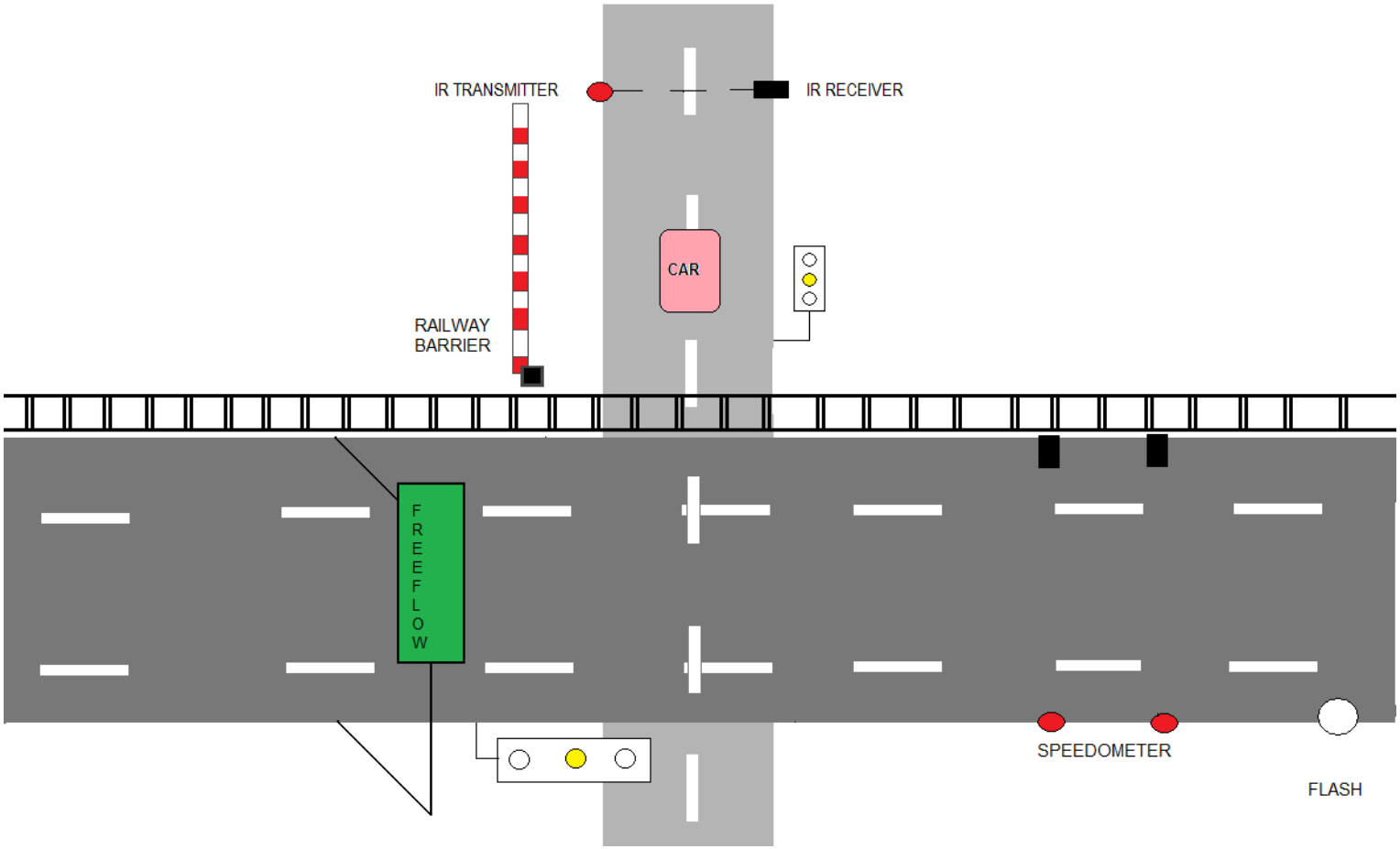
- Highway road light
- Service road light
- Car on service road
- LCD display
- Car exceed speed limit
- Railway barrier

FUNCTIONING



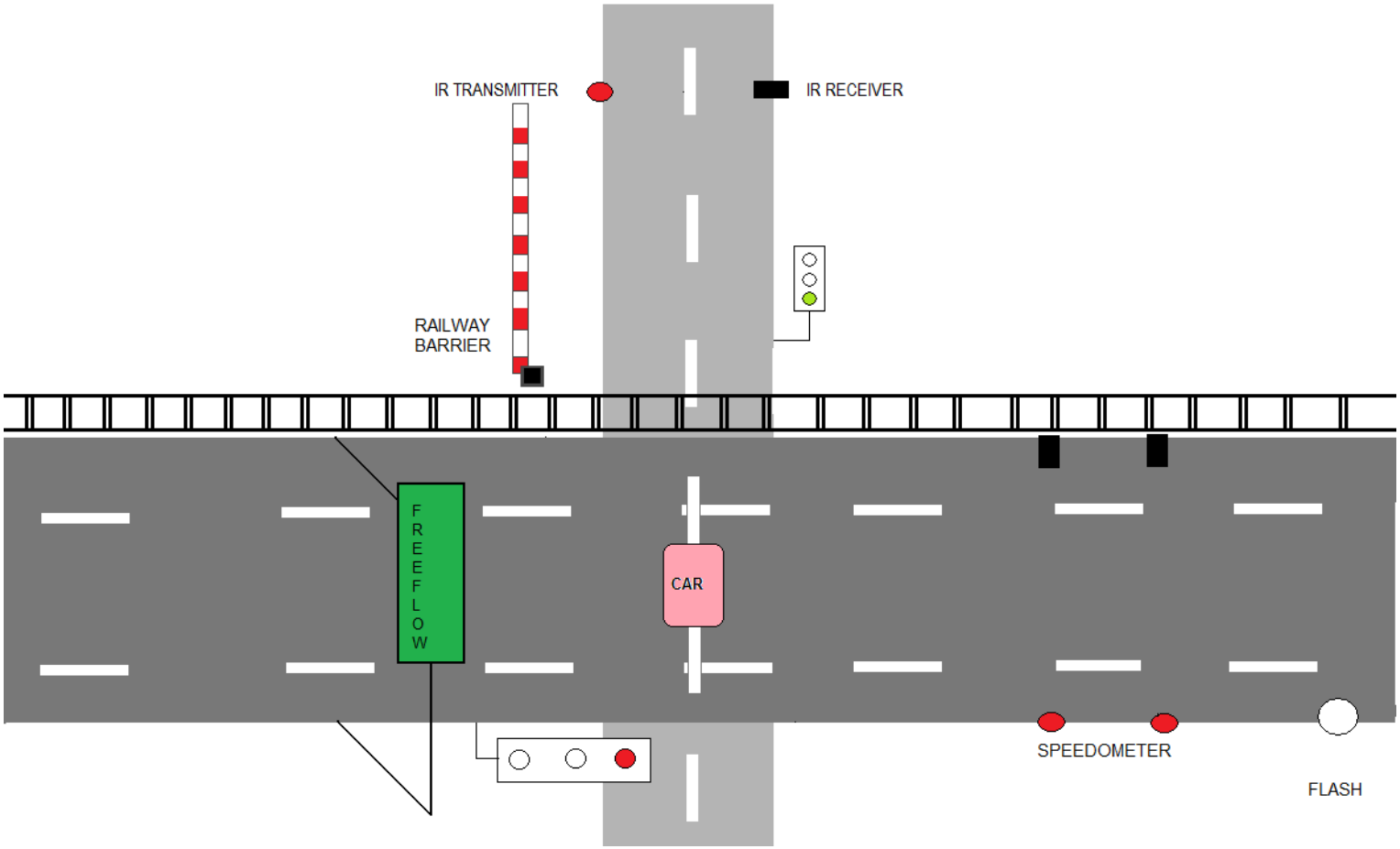
- Highway road light = Green
- Service road light = Red
- Car on service road = No
- LCD display = -
- Car exceed speed limit = -
- Railway barrier = Up

1. CAR ON SERVICE ROAD



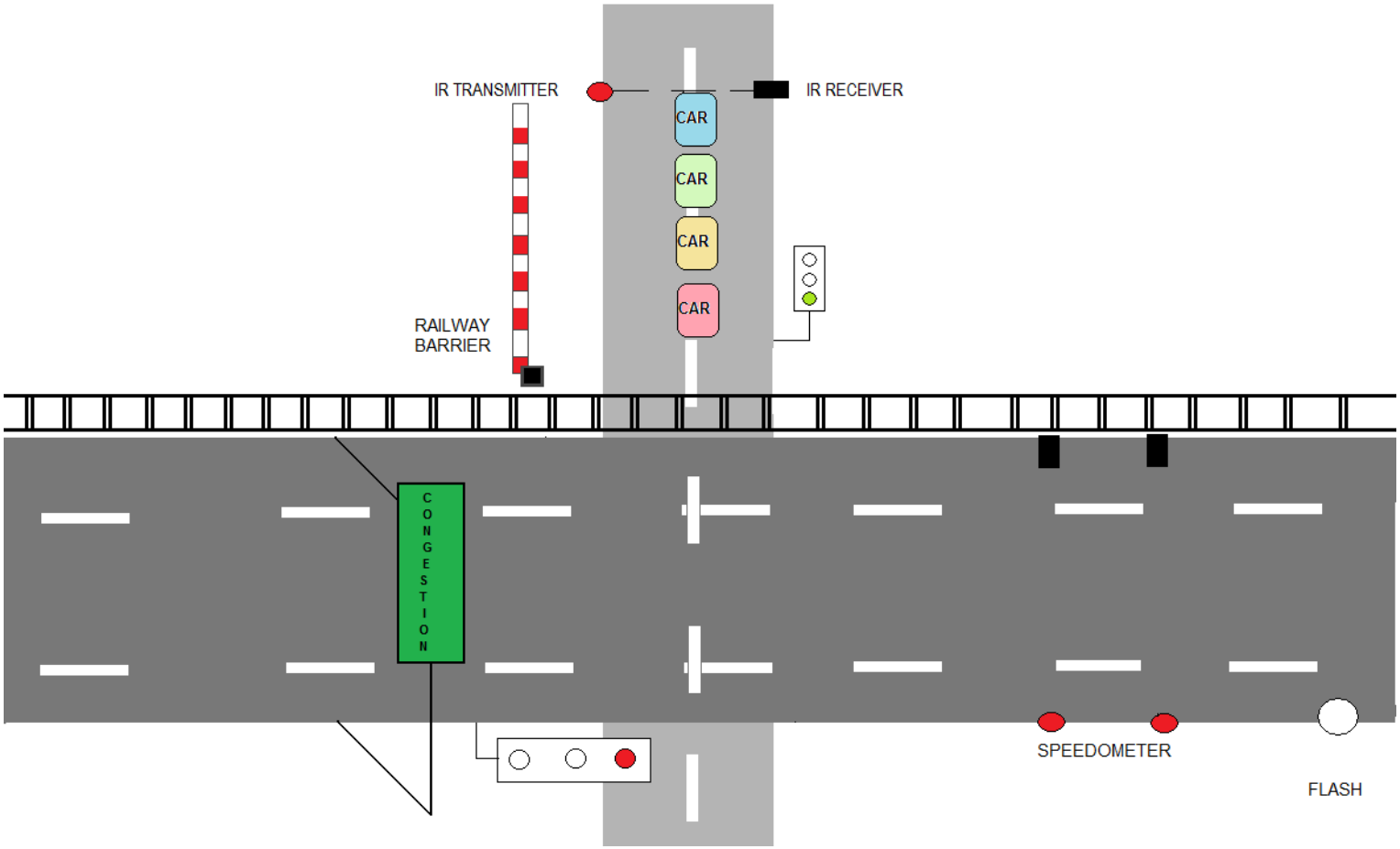
- Highway road light = Yellow
- Service road light = Yellow
- Car on service road = Yes
- LCD display = Free flow
- Car exceed speed limit = -
- Railway barrier = Up

2. WAIT FOR CAR TO CROSS



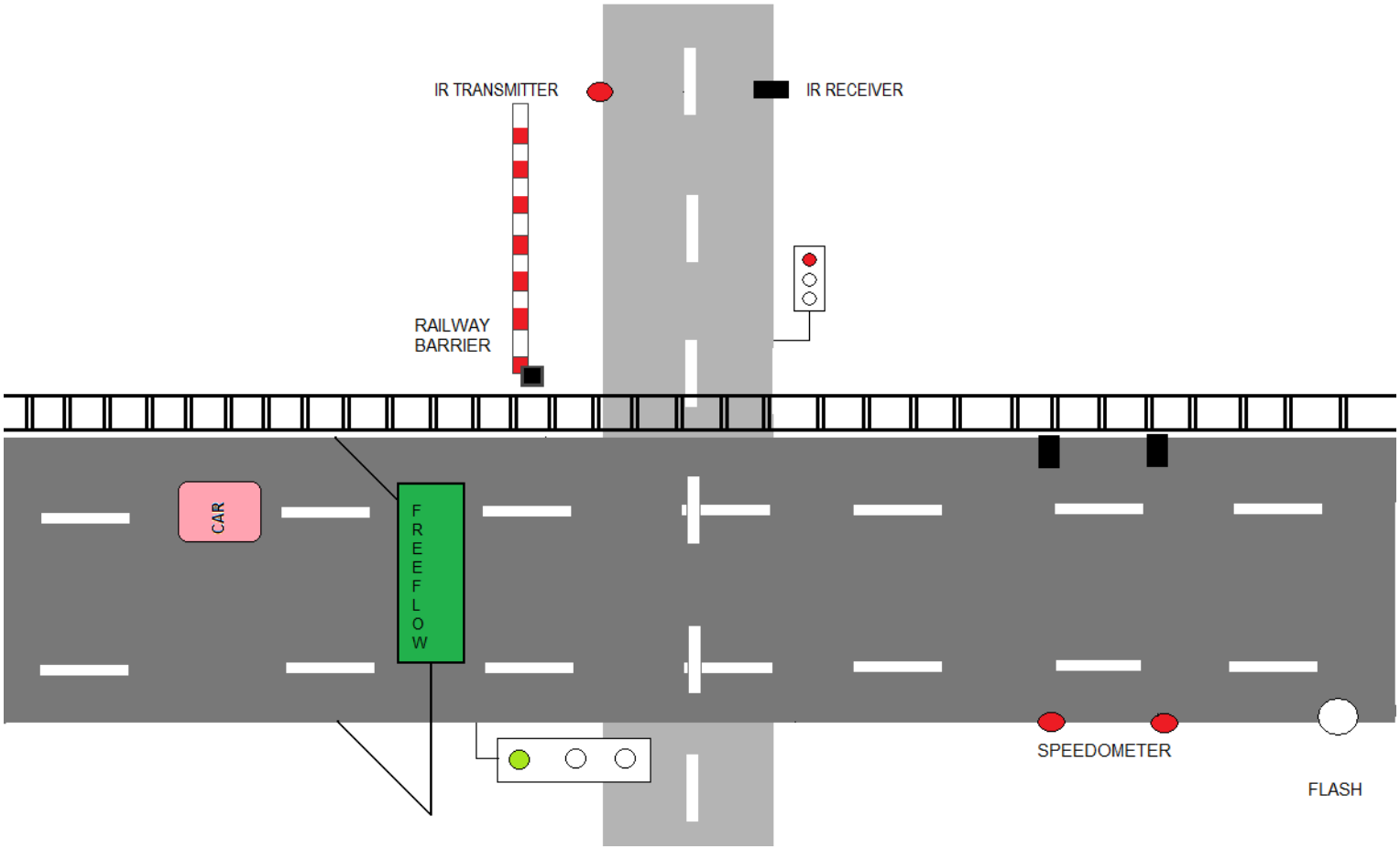
- Highway road light = Red
- Service road light = Green
- Car on service road = Yes
- LCD display = Free flow
- Car exceed speed limit = -
- Railway barrier = Up

3. MORE THAN 2 CARS ON SERVICE ROAD



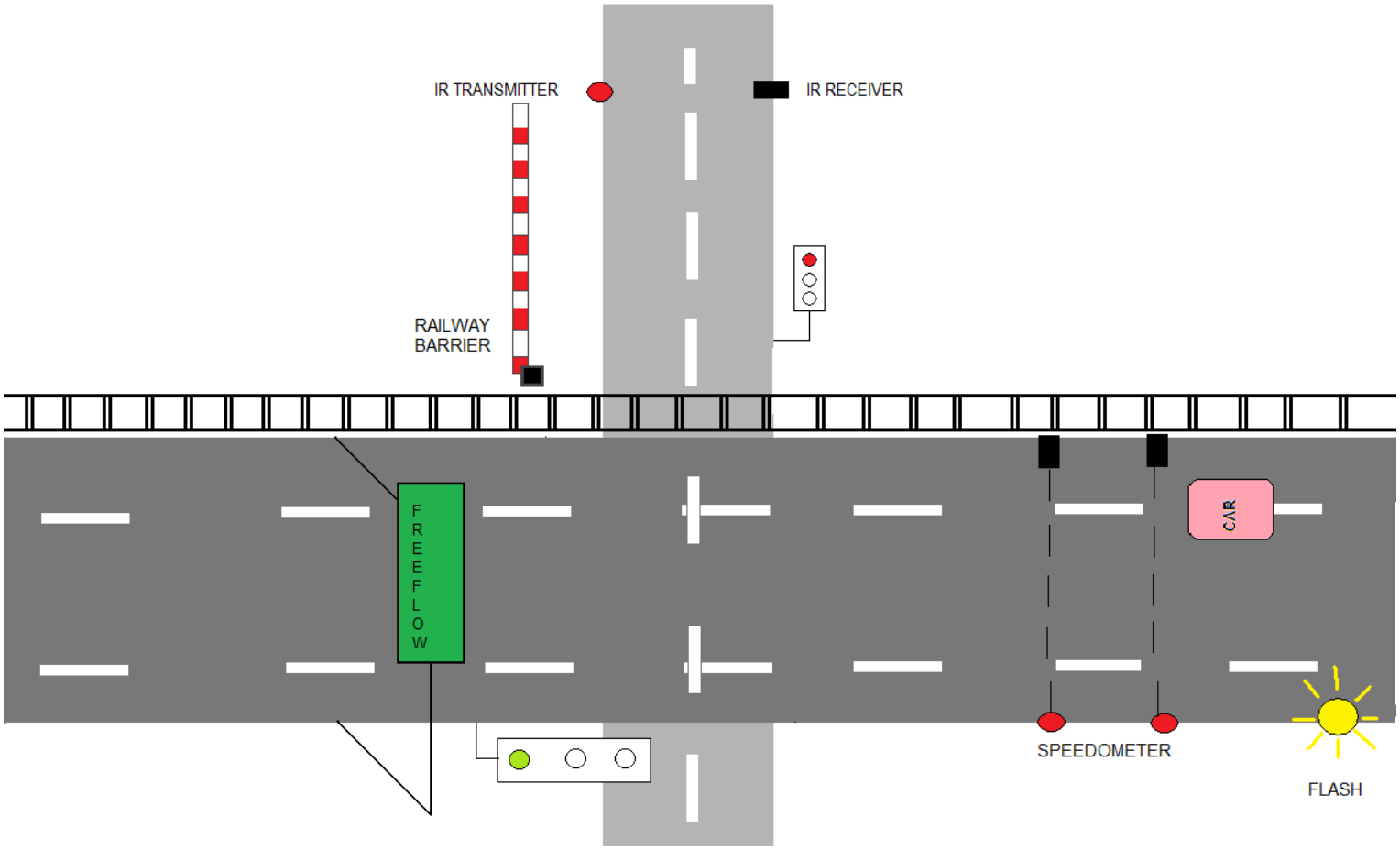
- Highway road light = Red
- Service road light = Green
- Car on service road = Yes
- LCD display = Congestion
- Car exceed speed limit = -
- Railway barrier = Up

4. CAR ON HIGHWAY



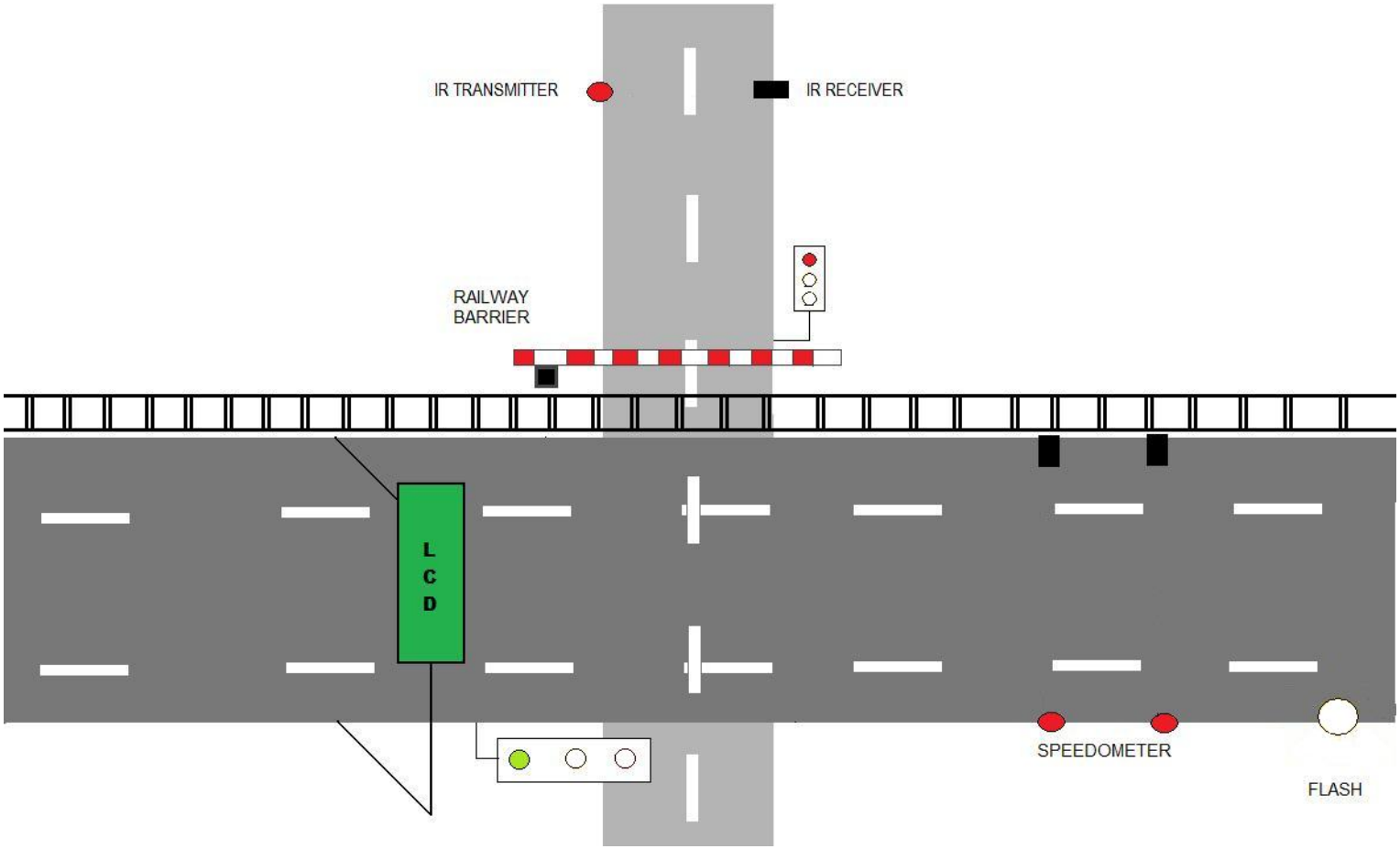
- Highway road light = Green
- Service road light = Red
- Car on service road = No
- LCD display = -
- Car exceed speed limit = No
- Railway barrier = Up

5. CAR EXCEEDS SPEED LIMIT



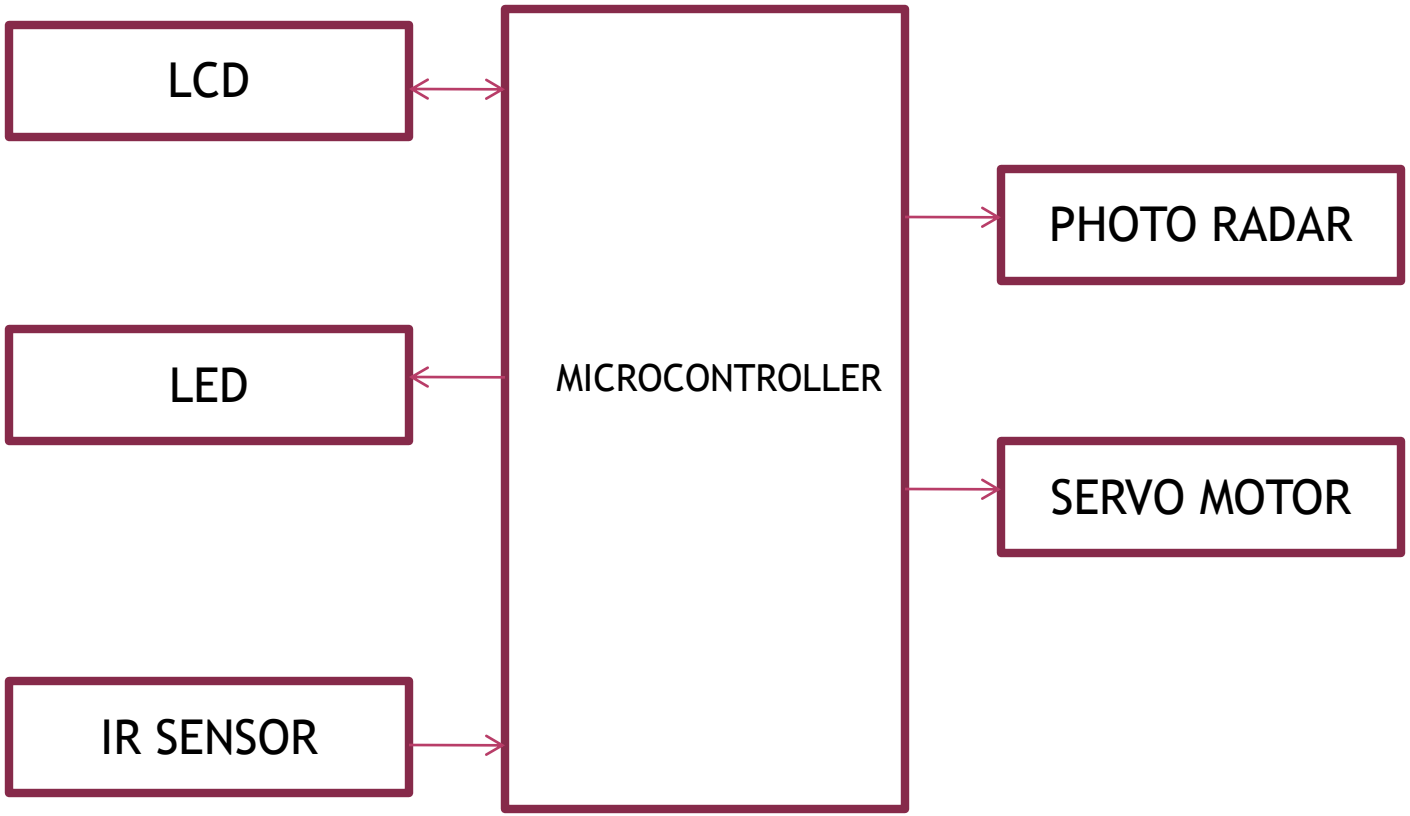
- Highway road light = Green
- Service road light = Red
- Car on service road = No
- LCD display = -
- Car exceed speed limit = Yes
- Railway barrier = Up

6. RAILWAY BARRIER



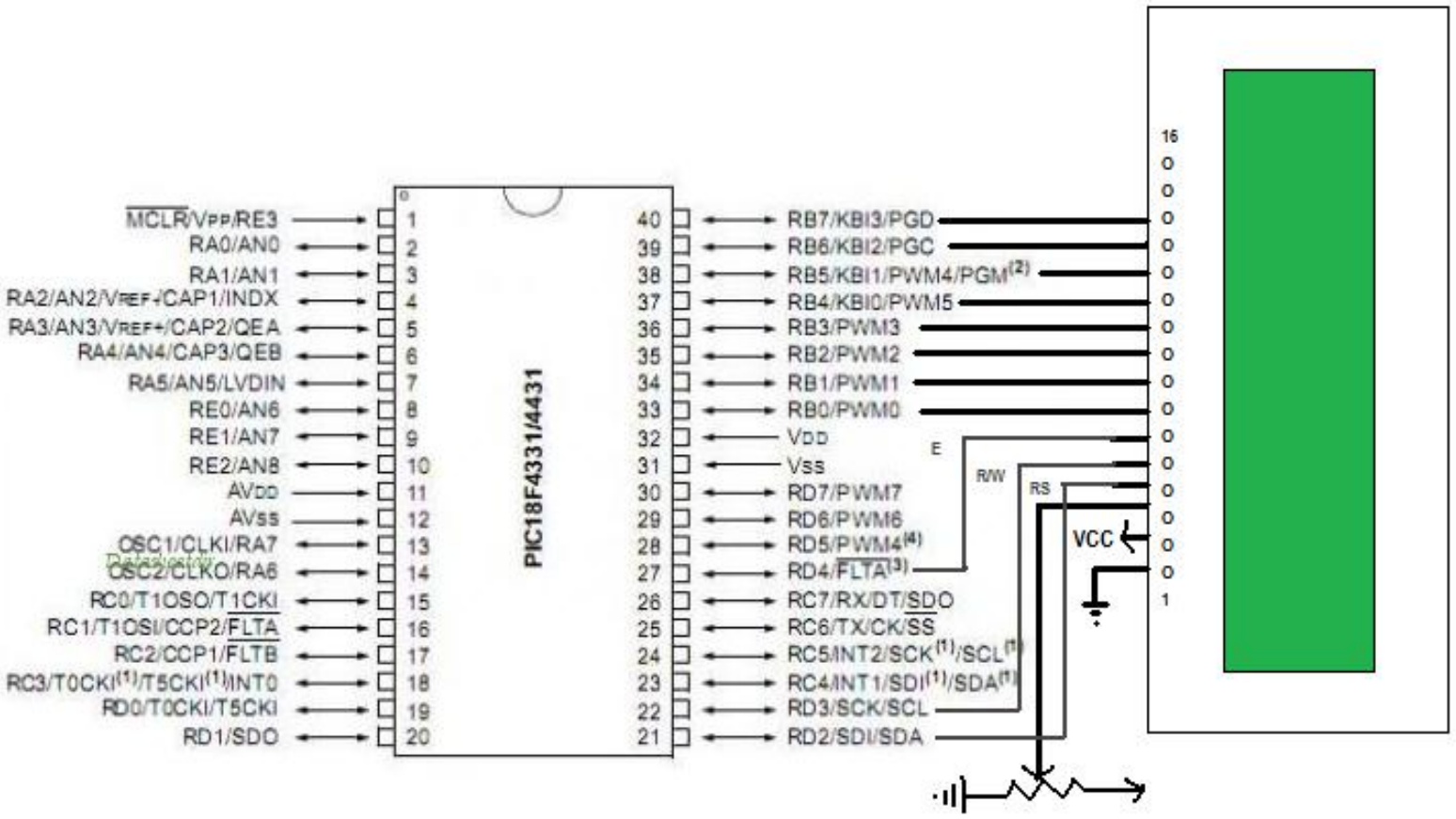
- Highway road light = Green
- Service road light = Red
- Car on service road = Does not matter
- LCD display = -
- Car exceed speed limit = -
- Railway barrier = Down

BLOCK DIAGRAM

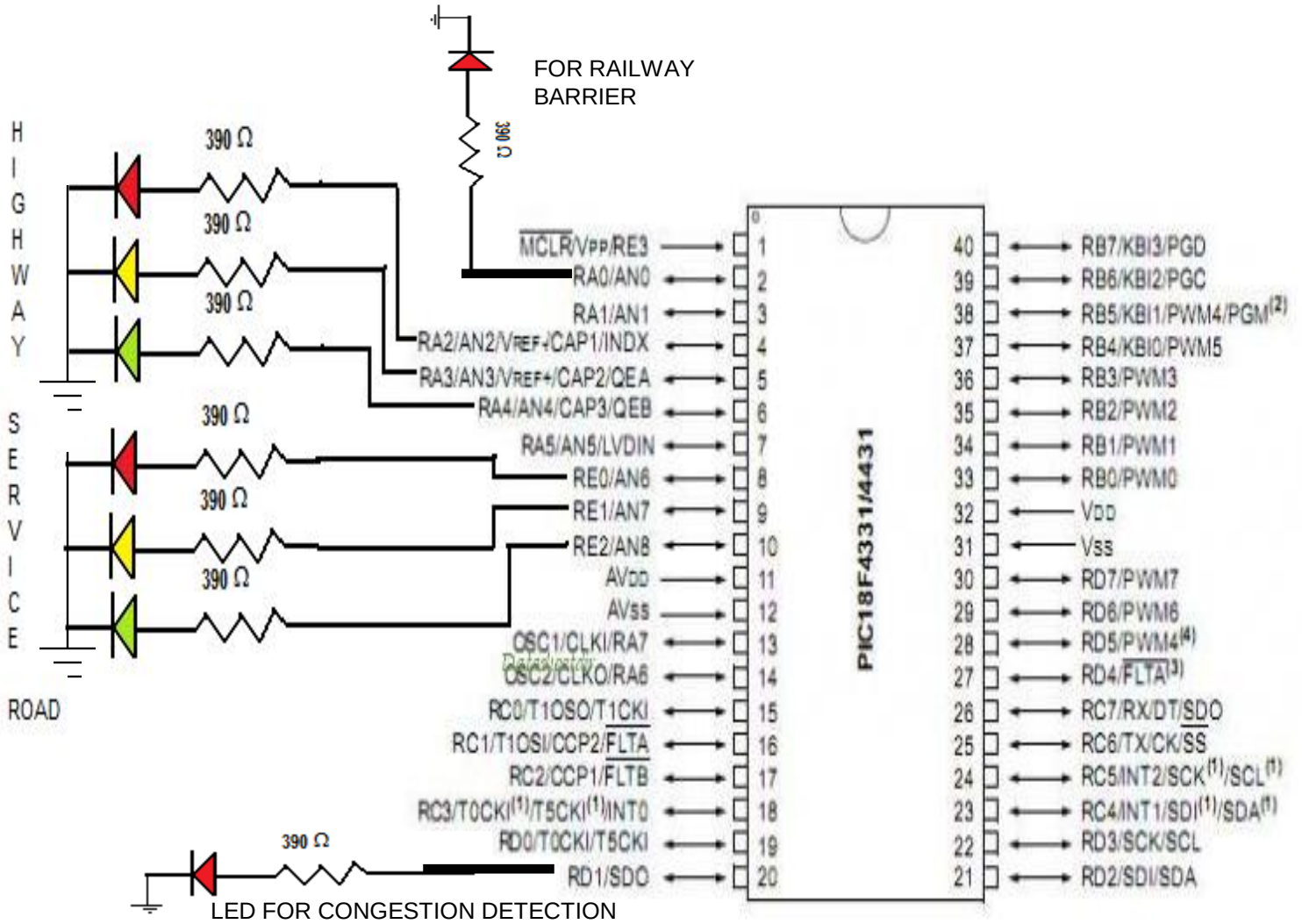


HARDWARE INTERFACING

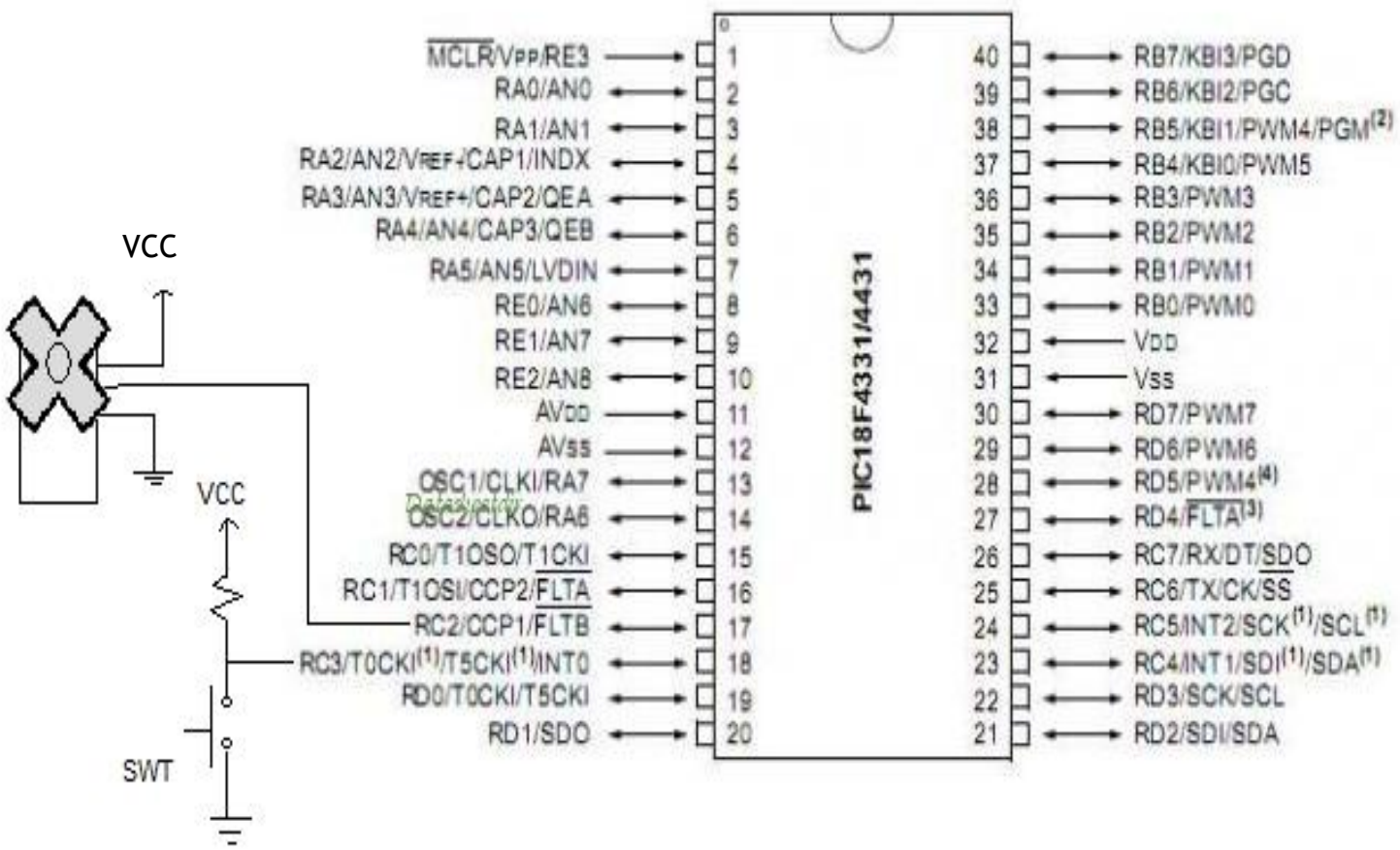
LCD INTERFACING



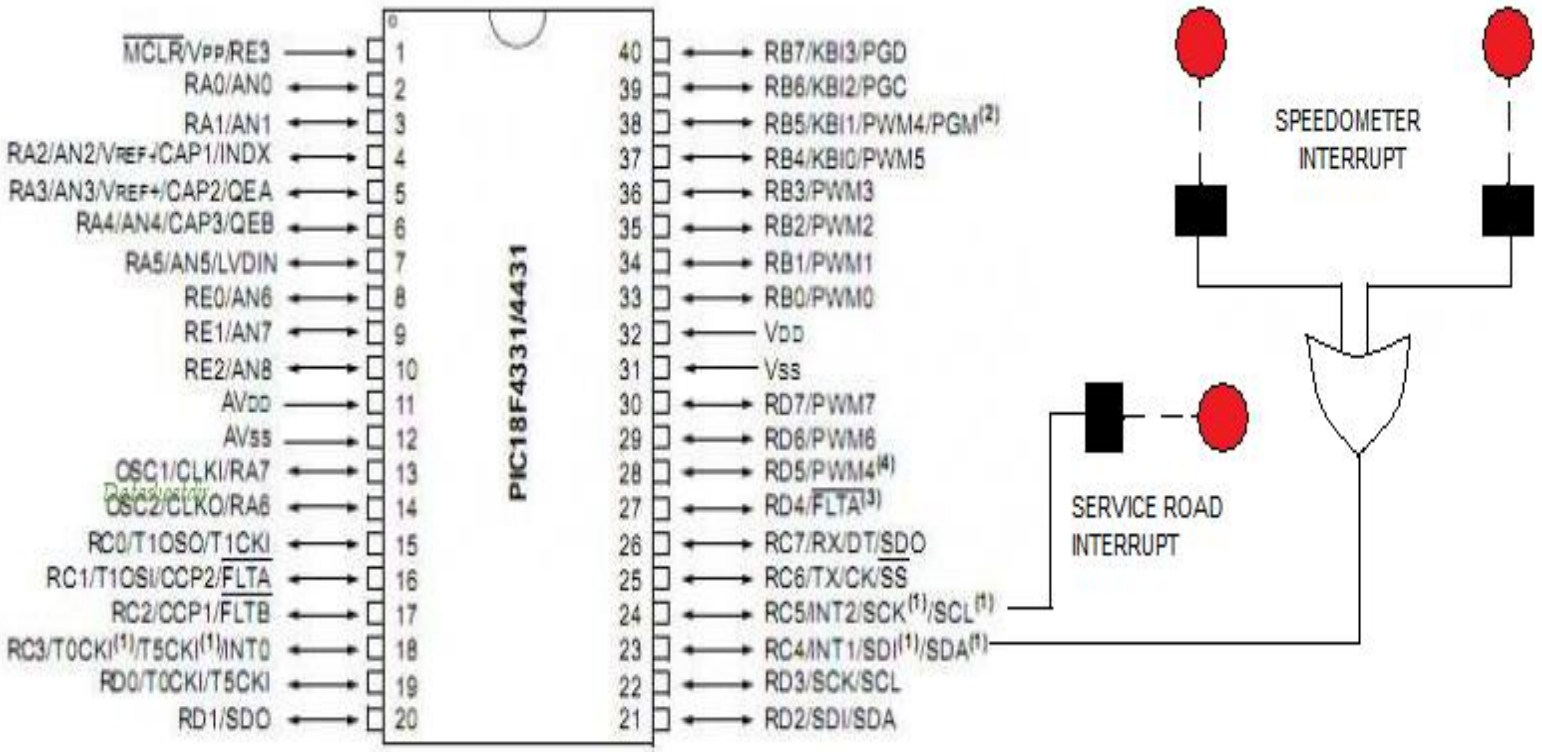
LED INTERFACING



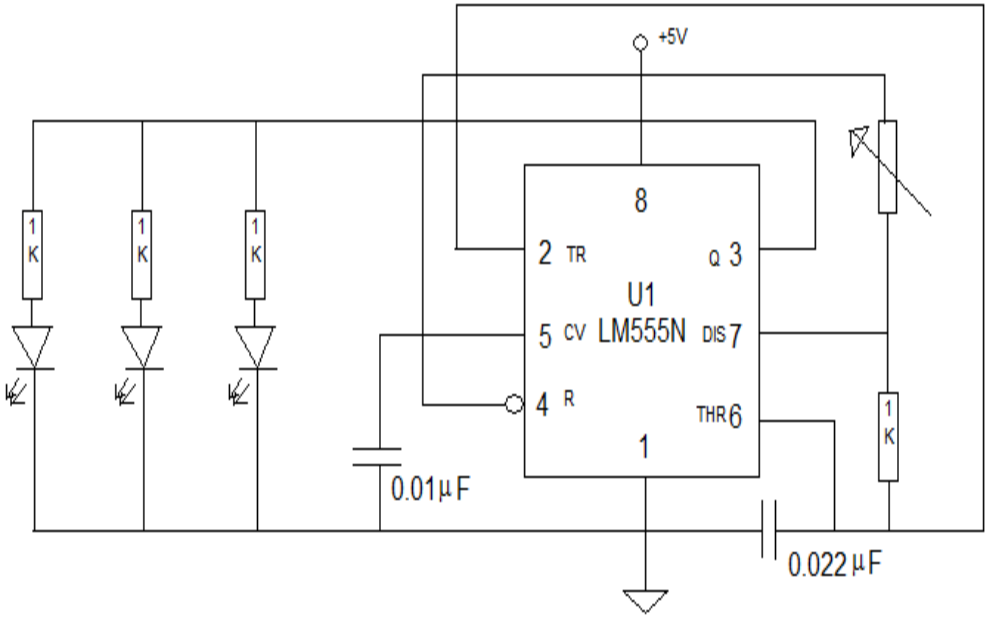
SERVO MOTOR INTERFACING

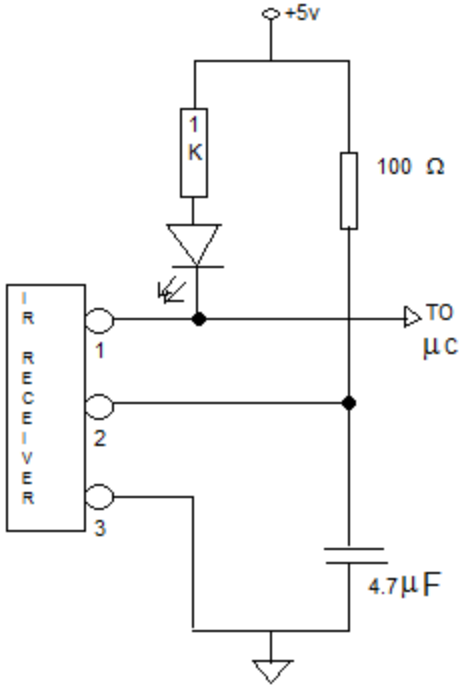


IR SENSOR INTERFACING



IR TRANSMITTER & RECEIVER





SOFTWARE DESCRIPTION

INTERRUPT SUBROUTINES

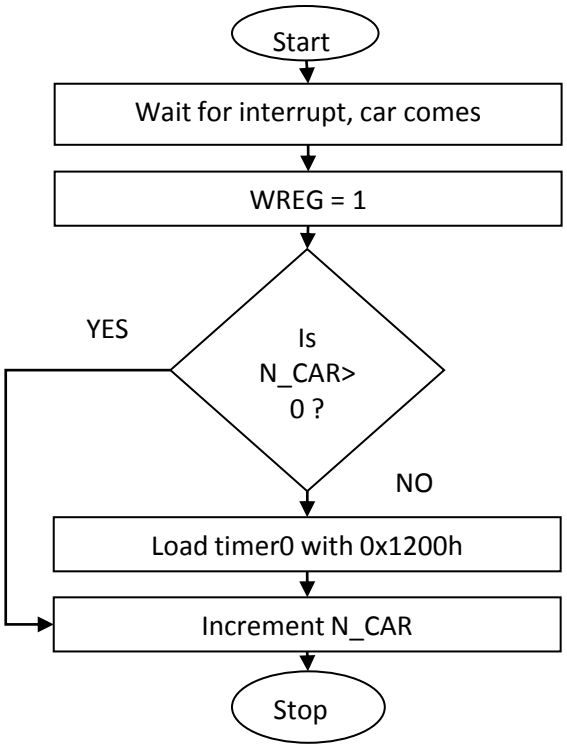
- We have used the following high priority interrupts:

  INT0 INT1 INT2

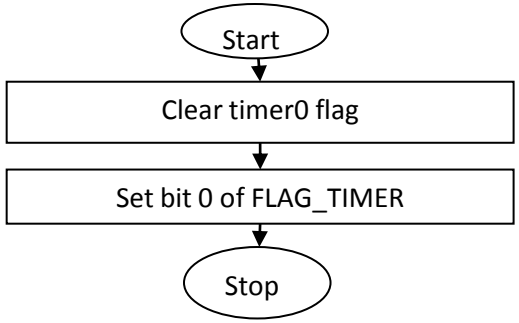
  TMR0 TMR1

  Also, TMR2 is used as a low priority interrupt
  - INT0- To turn on motor
  - TMR1- To generate PWM
  - INT1- To detect speed in speedometer
  - TMR2- To calculate speed of car in speedometer
  - INT2- To detect the traffic on service road
  - TMR0- To calculate number of cars on service road

CONGESTION DETECTION



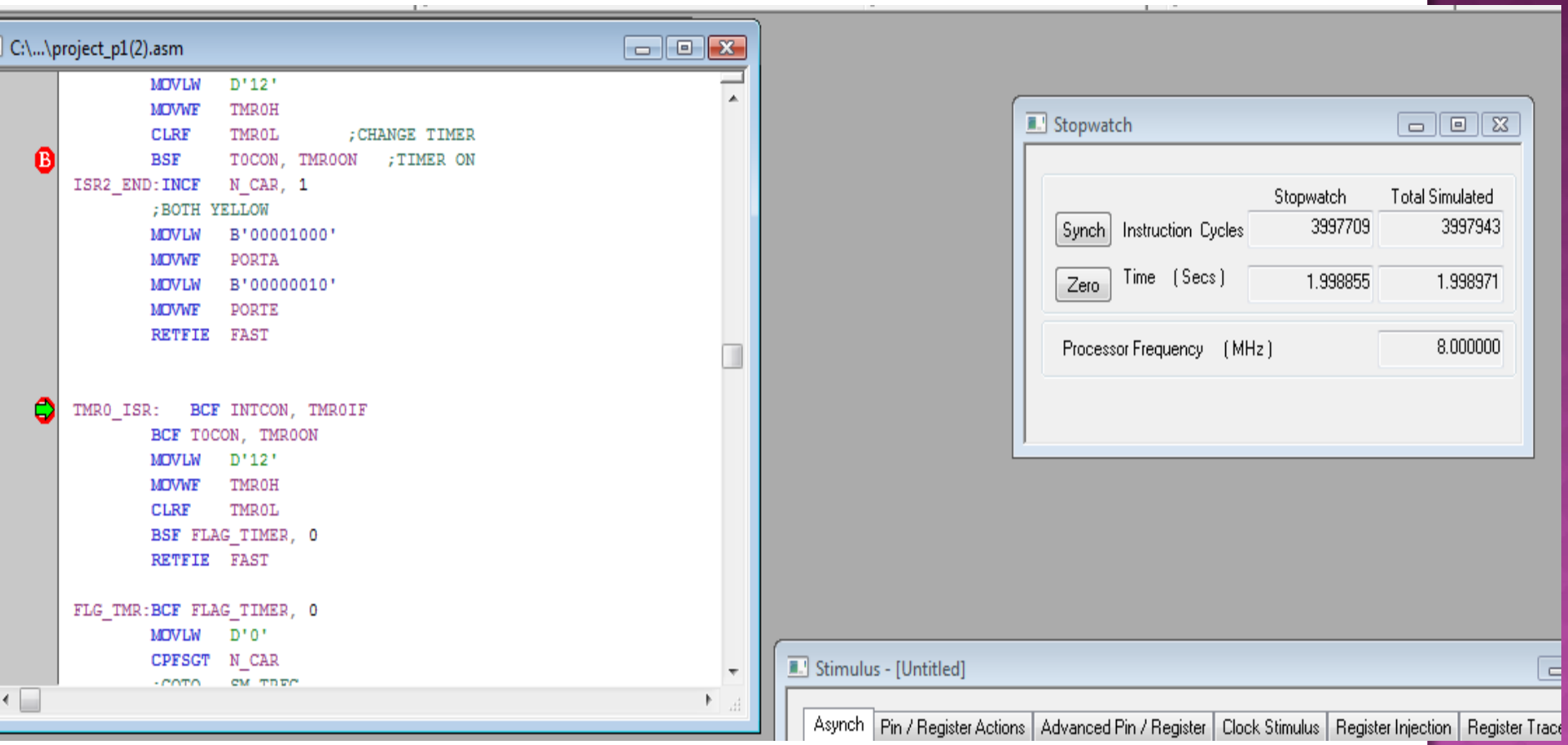
INT0 SUBROUTINE



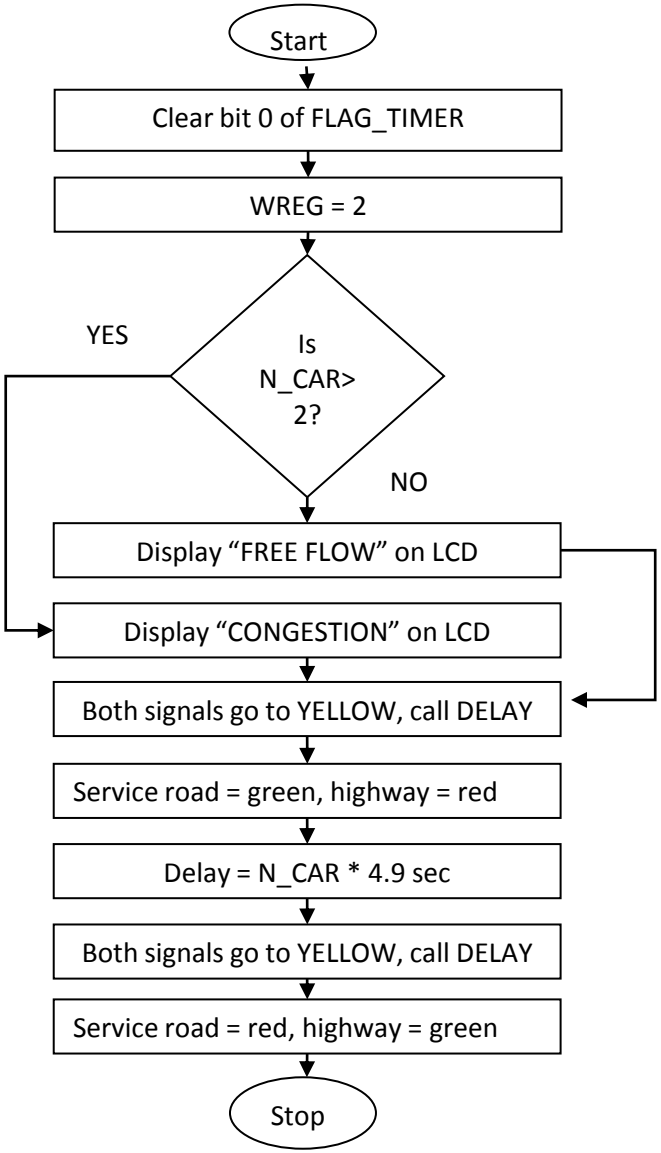
TIMER0 SUBROUTINE

TIMER0 is used as a 16 bit timer, detection on rising edge with 1:64 pre-scale. It generates a delay of 2 sec.

TIMER0 = 2 SEC

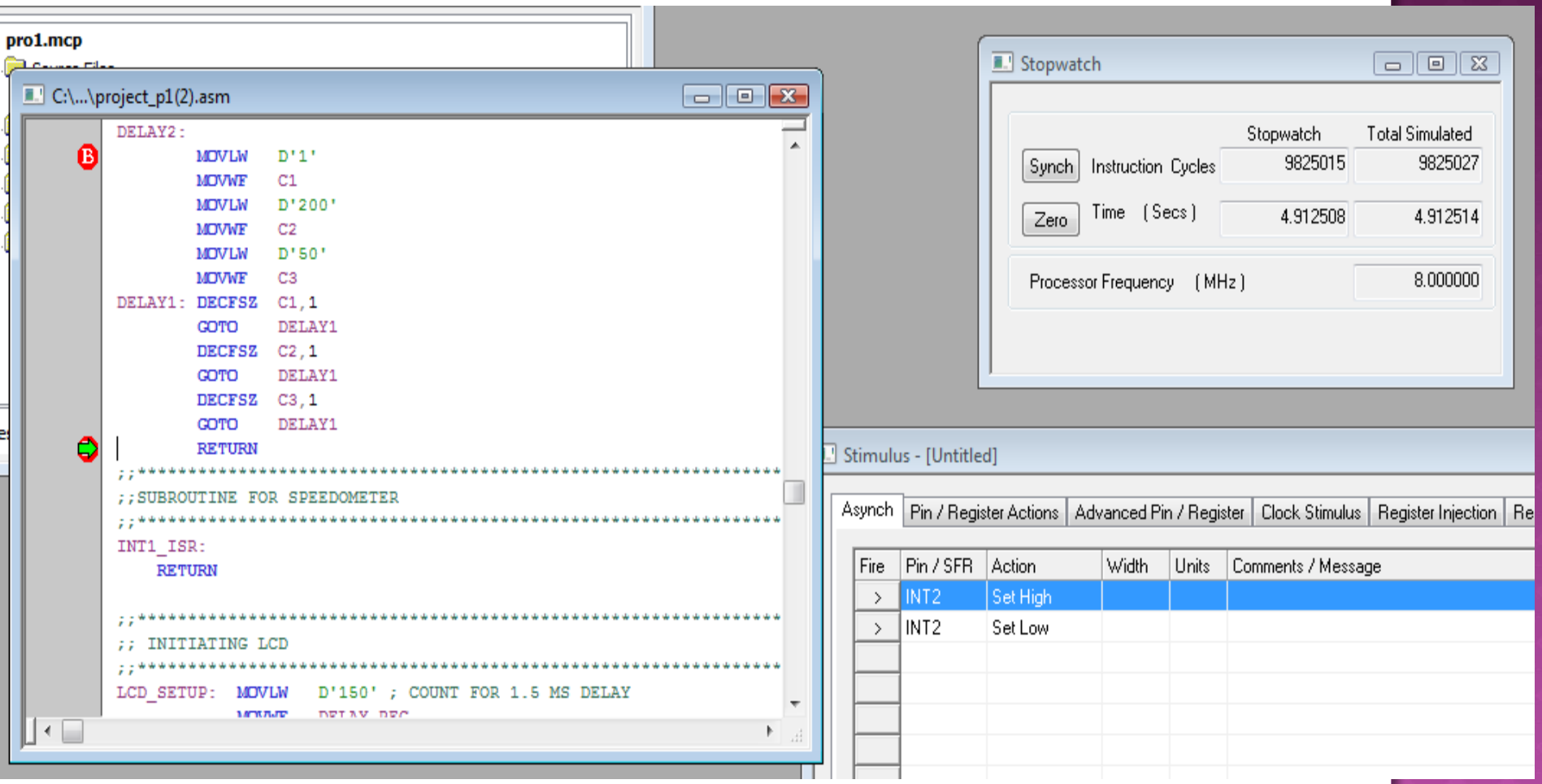

C:\...\project_p1(2).asm
MOVLW D'12'
MOVWF TMR0H
CLRF TMR0L ;CHANGE TIMER
BSF T0CON, TMR0ON ;TIMER ON
ISR2_END:INCF N_CAR, 1
;BOTH YELLOW
MOVLW B'00001000'
MOVWF PORTA
MOVLW B'00000010'
MOVWF PORTE
RETFIE FAST
TMR0_ISR: BCF INTCON, TMR0IF
BCF T0CON, TMR0ON
MOVLW D'12'
MOVWF TMR0H
CLRF TMR0L
BSF FLAG_TIMER, 0
RETFIE FAST
FLG_TMR:BCF FLAG_TIMER, 0
MOVLW D'0'
CPFSGT N_CAR
Stopwatch
Stopwatch
Total Simulated
Synch
Instruction Cycles
3997709
3997943
Zero
Time (Secs)
1.998855
1.998971
Processor Frequency (MHz)
8.000000
Stimulus - [Untitled]
Asynch
Pin / Register Actions
Advanced Pin / Register
Clock Stimulus
Register Injection
Register Trace

CONGESTION DETECTION (CONTD.)

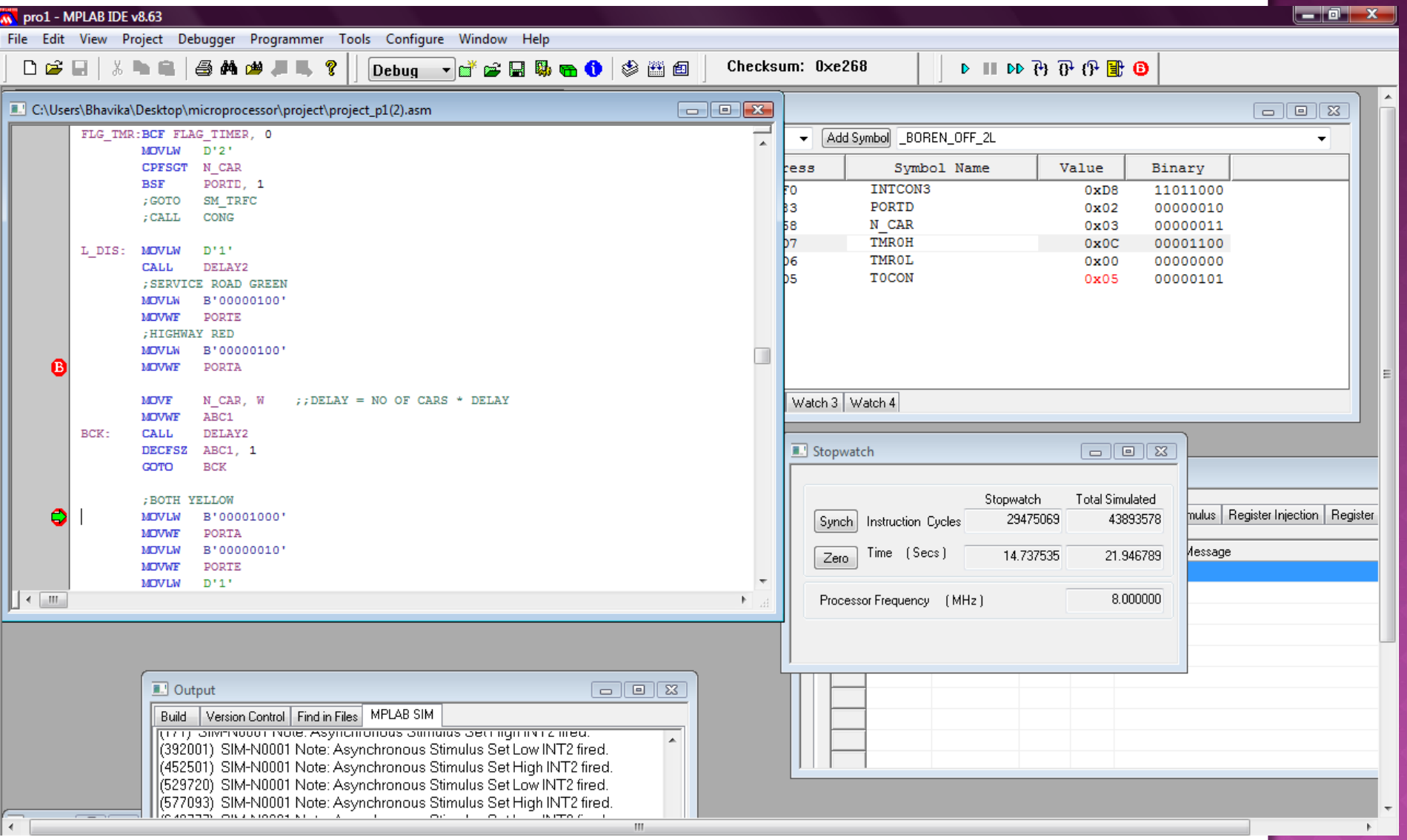


SUBROUTINE FOR TRAFFIC LIGHT DISPLAY

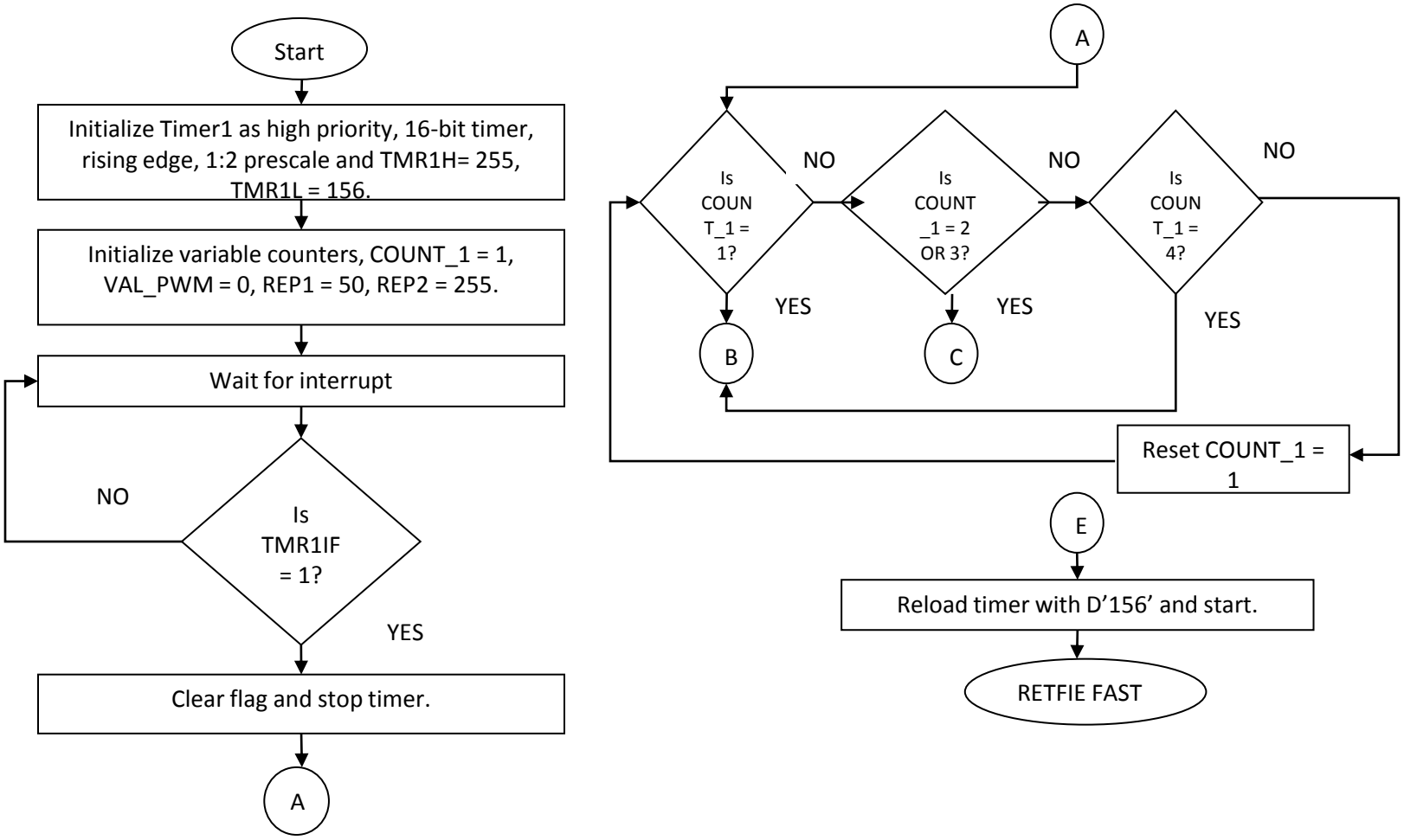
DELAY OF 4.9 SEC



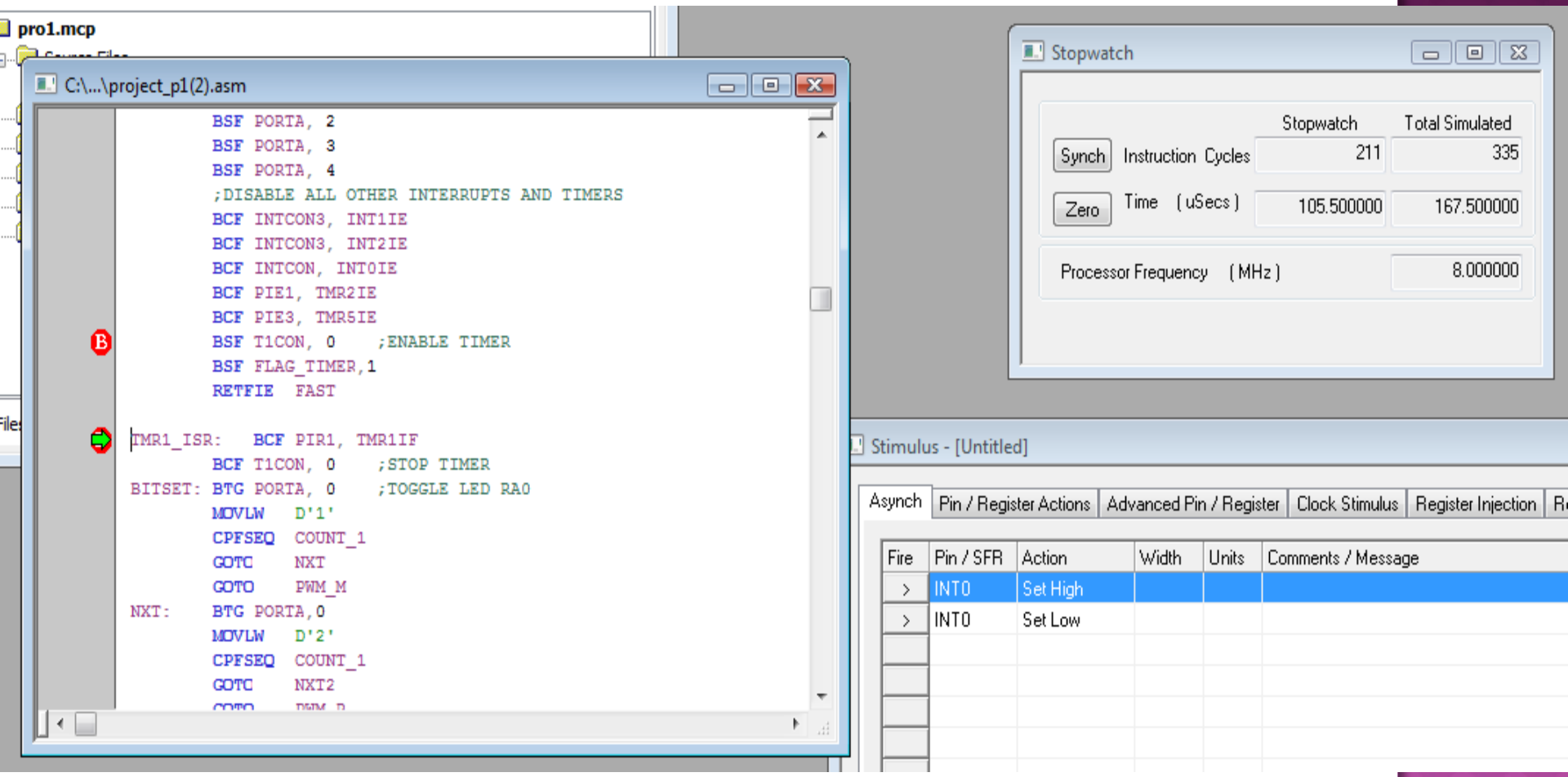
CONGESTION DETECTED

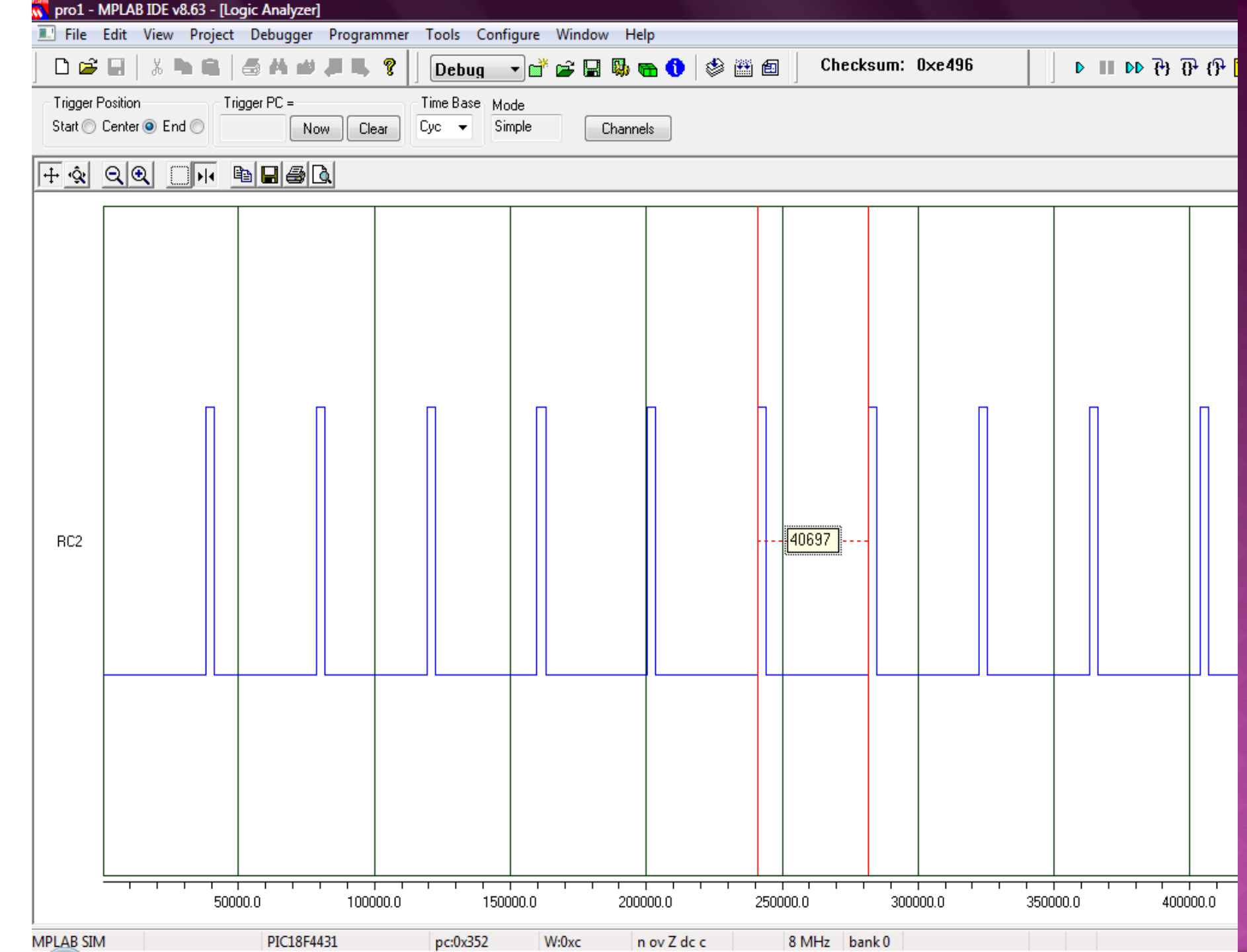


SERVO MOTOR CONTROL FOR RAILWAY BARRIER

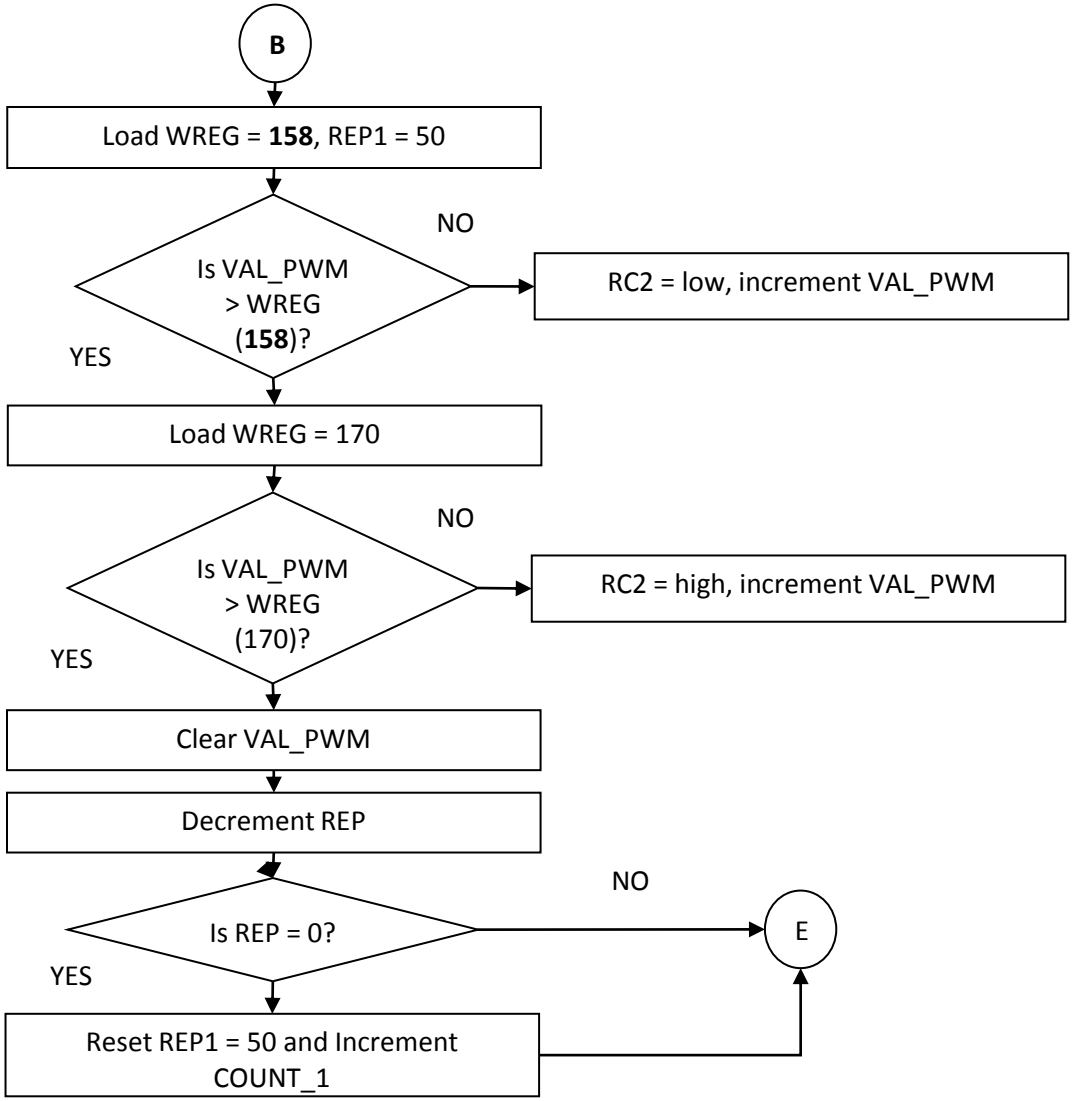


TIMER1 INTERRUPTS AT EVERY 0.1MS

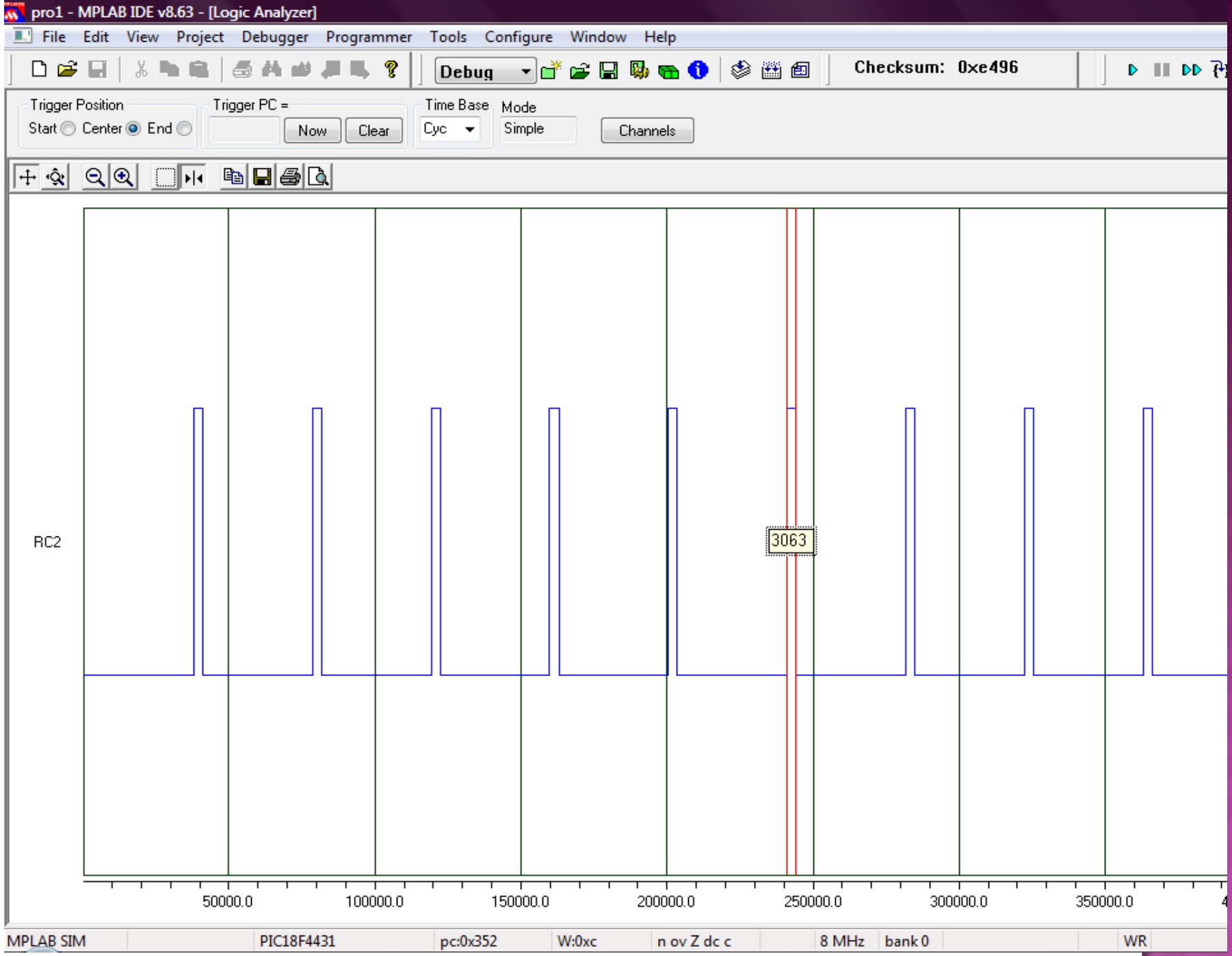



pro1 - MPLAB IDE v8.63 - [Logic Analyzer]
File Edit View Project Debugger Programmer Tools Configure Window Help
Debug
Checksum: 0xe496
Trigger Position
Start Center End
Trigger PC =
Now
Clear
Time Base
Cyc
Mode
Simple
Channels
RC2
40697
50000.0
100000.0
150000.0
200000.0
250000.0
300000.0
350000.0
400000.0
MPLAB SIM
PIC18F4431
pc:0x352
W:0xc
n ov Z dc c
8 MHz
bank 0

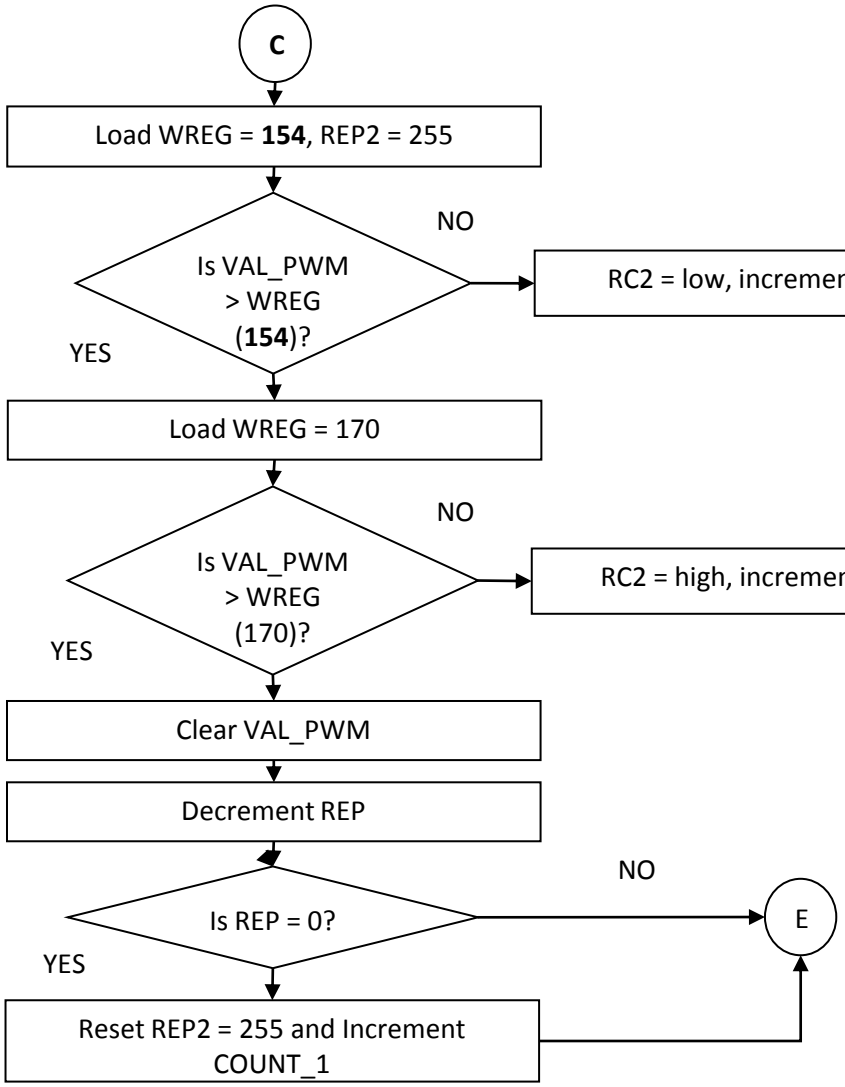
PWM GENERATION FOR MIDDLE POSITION



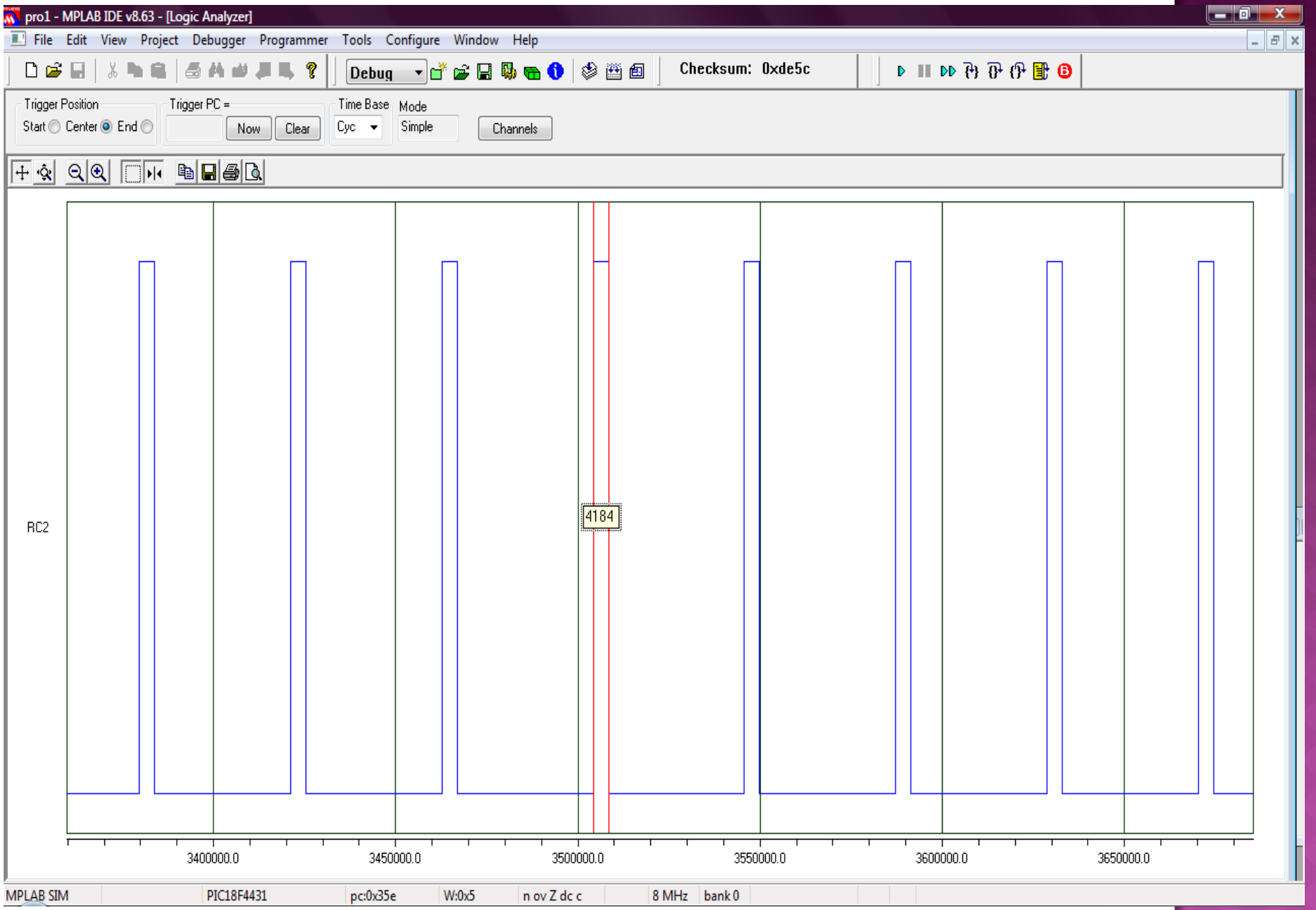
Pulse width = 1.5ms


pro1 - MPLAB IDE v8.63 - [Logic Analyzer]
File Edit View Project Debugger Programmer Tools Configure Window Help
Debug
Checksum: 0xe496
Trigger Position
Start Center End
Trigger PC =
Now
Clear
Time Base
Cyc
Mode
Simple
Channels
RC2
3063
50000.0
100000.0
150000.0
200000.0
250000.0
300000.0
350000.0
MPLAB SIM
PIC18F4431
pc:0x352
W:0xc
n ov Z dc c
8 MHz
bank 0
WR

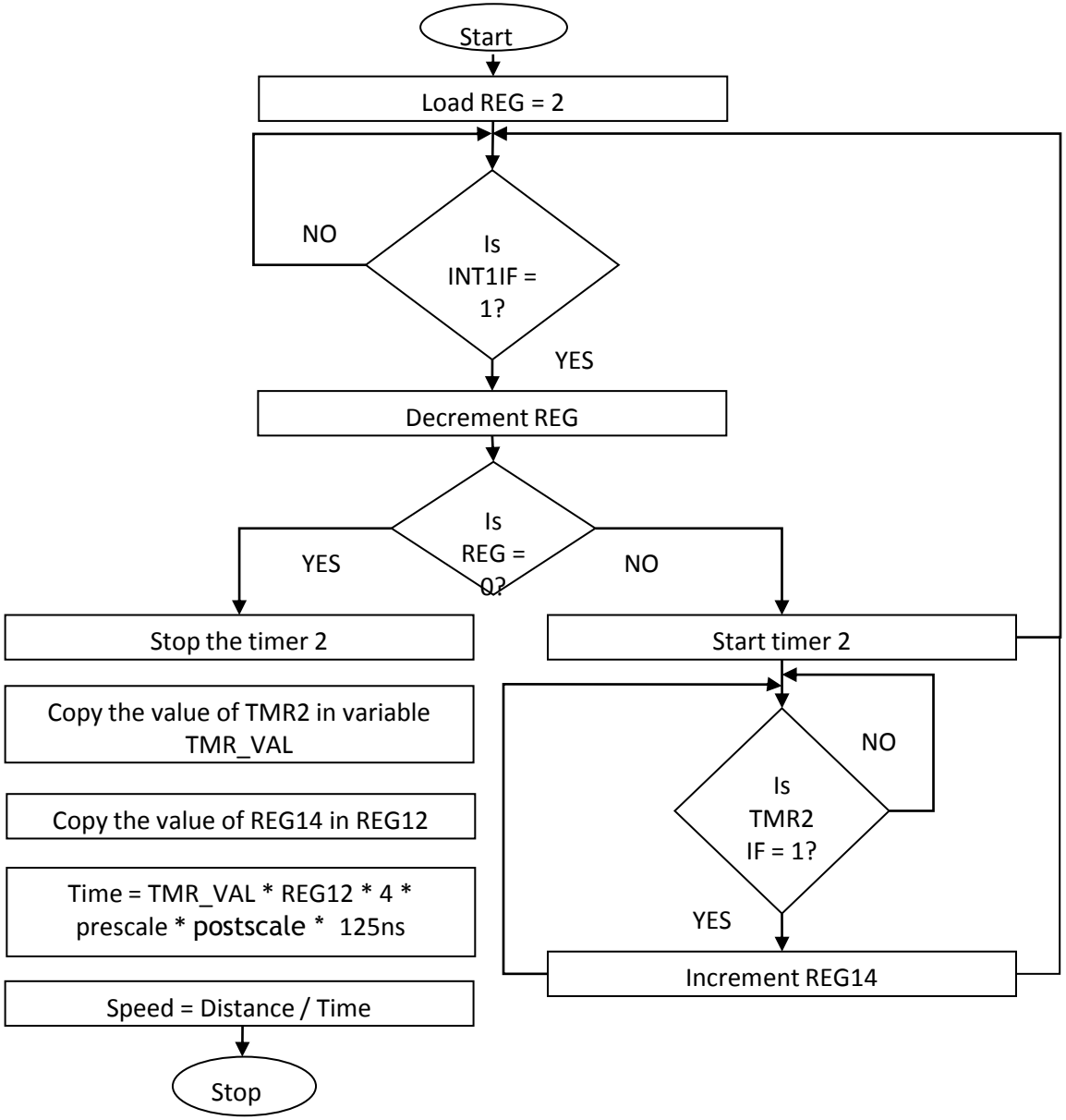
PWM GENERATION FOR RIGHT ROTATION

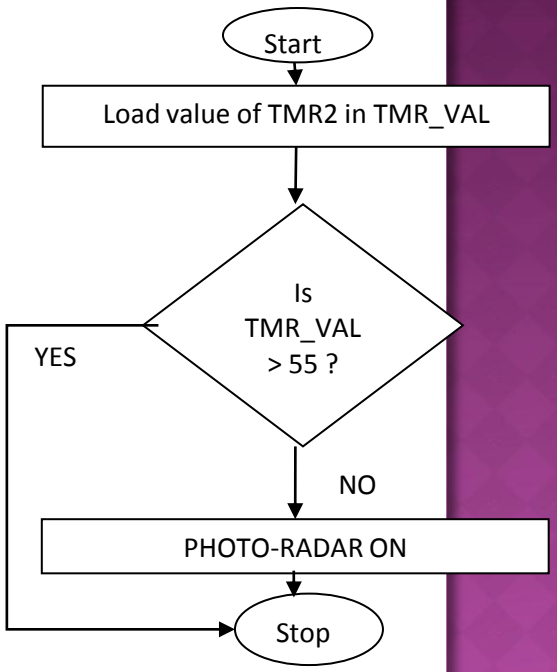


Pulse width = 2ms


pro1 - MPLAB IDE v8.63 - [Logic Analyzer]
File Edit View Project Debugger Programmer Tools Configure Window Help
Debug
Checksum: 0xde5c
Trigger Position
Start Center End
Trigger PC =
Now
Clear
Time Base
Cyc
Mode
Simple
Channels
RC2
4184
3400000.0
3450000.0
3500000.0
3550000.0
3600000.0
3650000.0
MPLAB SIM
PIC18F4431
pc:0x35e
W:0x5
n ov Z dc c
8 MHz
bank 0

SPEEDOMETER





DISCUSSION

- It was our effort to combine maximum number of techniques that we learned in this course.

- It was challenging to use 6 interrupts together in one program, but it was best to give all but one the high priority. We learned:
  - It is very important to clear flags immediately after entering in the subroutine.
  - It is good to keep like subroutines nearby.
  - If required, all other interrupts may be disabled when inside in a major subroutine.

- We also learned that each motor is different, and unlike other subroutines, the same PWM generation program may not be used with all motors. It is best to test PWM generation using LOGIC ANALYZER as the values change for every code depending on number of instruction cycles.

- Also, the synchronization between two interrupt in case of speedometer was difficult to achieve, which we rectified by using TMR2 in low priority.

- We initially planned to use LCD as explained, but due to certain synchronization errors, we used LEDs to display our results.
  - A bit change at RB7 can generate a high priority interrupt
  - If disabled, it does not detect the corresponding pin during LCD functioning
  - We were unable to overcome this error

LIMITATIONS

- Our project provides various options but can be improved further more:
  - IR sensors are not powerful, hence other stronger types of sensors would be required for real time application.
  - We assumed that the highway has at a time only one car. For a regular 6 lane highway, we need to have 6 sensors, one for each lane.
  - If a car is too slow, it might over run the timer values, hence detect very high speed instead of too slow.
  - If the sensors are too close, or there are IR reflectors, or high voltage wires near the receiver, it might interfere.
  - If traffic load is high on service road, the controller will work in the same way as a regular controller.
  - The speed which is retrieved from our speedometer is not very accurate as the there is no resource for calibration.

CURRENT USE AND FUTURE PROSPECTS

- This kind of a controller is already implemented in a lot places. The most popular one being a photo-radar.
- Although the technique of counting car on service road is not very popular, yet a similar approach is still used in controller of trains.
- Also, the speed detection which is done in our program is not very popular either.
- All these techniques are easy to implement with very simple and user friendly integrations.
- The incoming traffic is optimized, in terms of saving time for traffic on highway.
- The vehicles become more fuel efficient too.
- Photo-radar can(and does too, to) help prevent accidents due to speeding and help regulate traffic law enforcement on roads, specially the ones which may not be easily monitored by physical presence.
- Congestion detection technique can help direct the route on highway through a secondary route, to prevent further congestion.

CONCLUSION

- The project is a very efficient way of optimizing traffic, with redefinition of threshold values for a real time application.
- The project works to control traffic on both roads according to traffic on service road, as well as indicate congestion for more than 2 cars.
- It also works to put a barrier down for an incoming train.
- Also, we were able to detect a speeding car.

THANK YOU