EMBEDDED SYSTEMS PROJECT

Distance Indicator

Jordi Gutierrez
Ignacio Salan

CONTENTS OF THE PRESENTATION

- **Introduction**
- **Aim of the Project**
- **Technical Details of the Project**
- **Simulation and experimental Results**
- **Conclusions**

Introduction

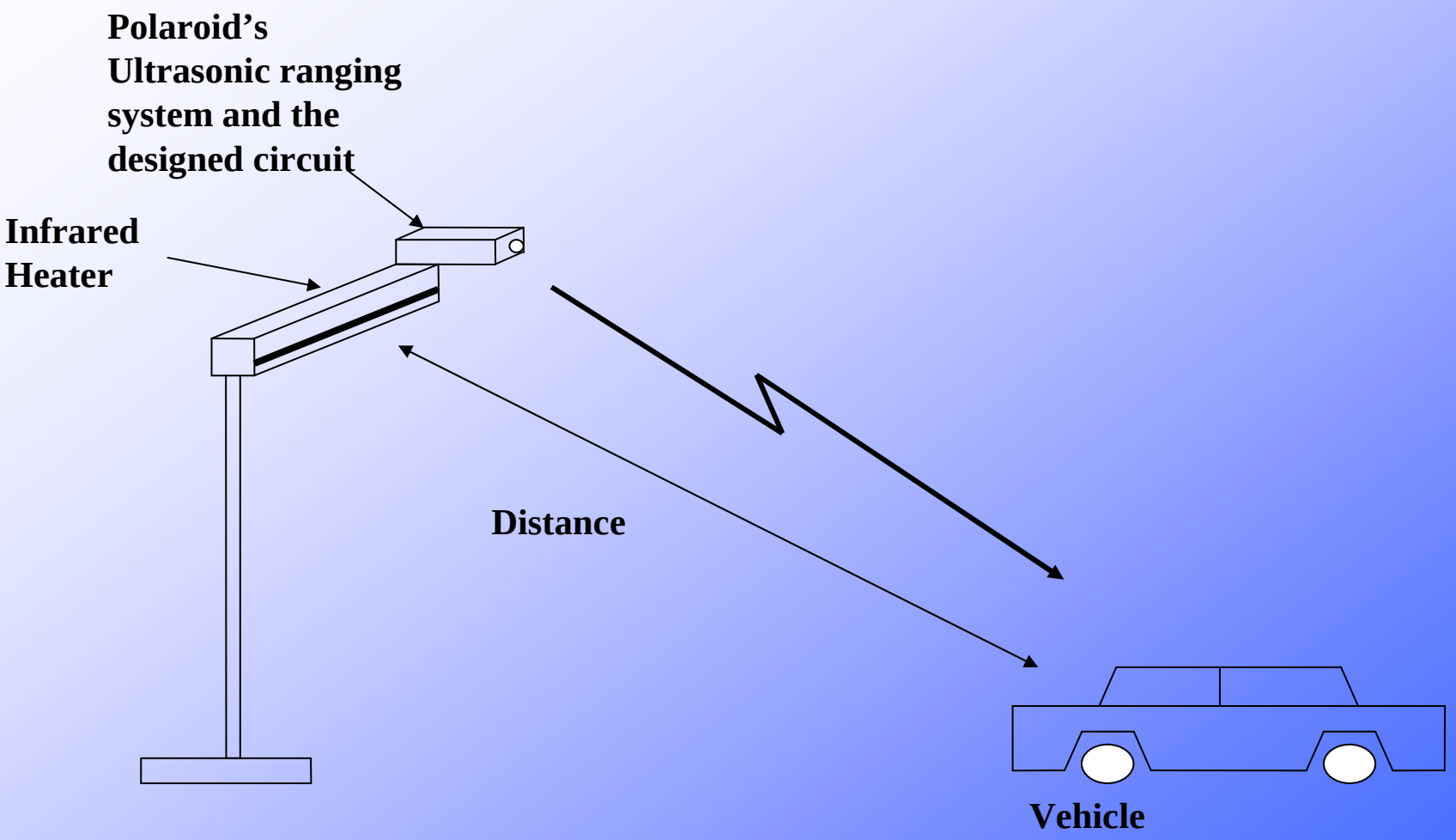
This project is concerned with the design of an electronic circuit with a microcontroller for an application of TRISK. This is a local company based in Sunderland. They are world leaders in the design and manufacture of mobile and drive-in infrared paint curing equipment for the automotive industry.

They are currently replacing much of the old control electronics and mechanical timers and switches in their equipment with PIC microcontrollers. An enhancement to their equipment that is currently under consideration is the inclusion of a distance indicator. The distance from the infrared heater to the vehicle is critical for optimum performance.

Aim of the Project

The main aim of this project is to implement a device to control the Polaroid's ultrasonic ranging system. This device must be able to control the ultrasonic system sending to it the proper control signals and then displaying the results of the distance measurement.

The approximate diagram of the TRISK Company system with the designed circuit proposed in this project.

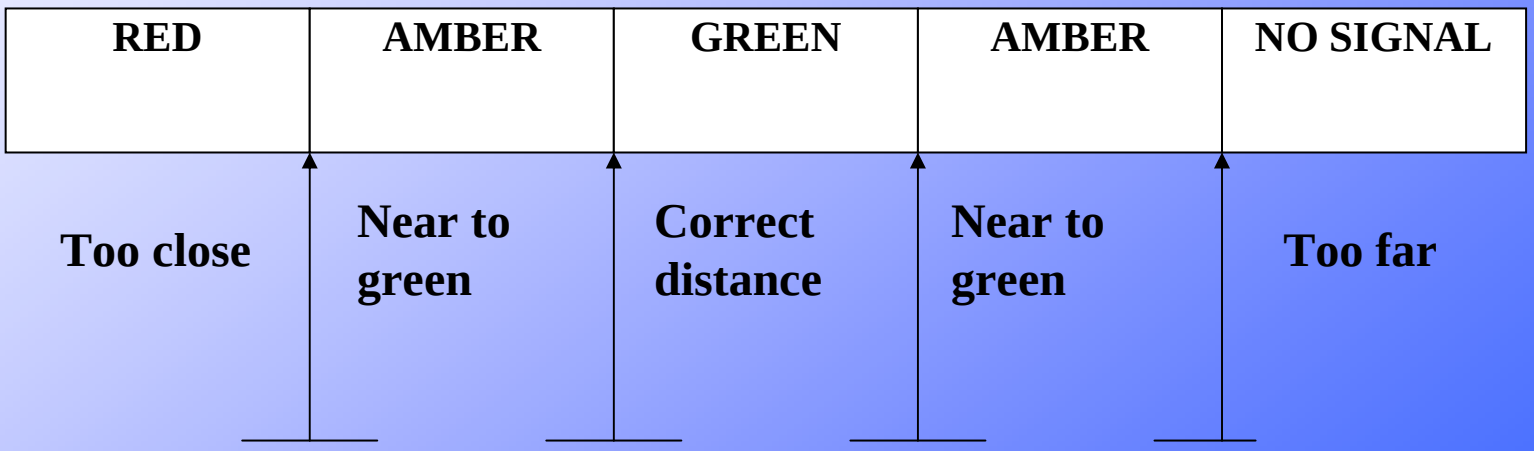


• **Three LED's to indicate the user the distance to the object.**

RED to indicate 'too close'

AMBER to indicate 'near green'

GREEN to indicate 'in range'



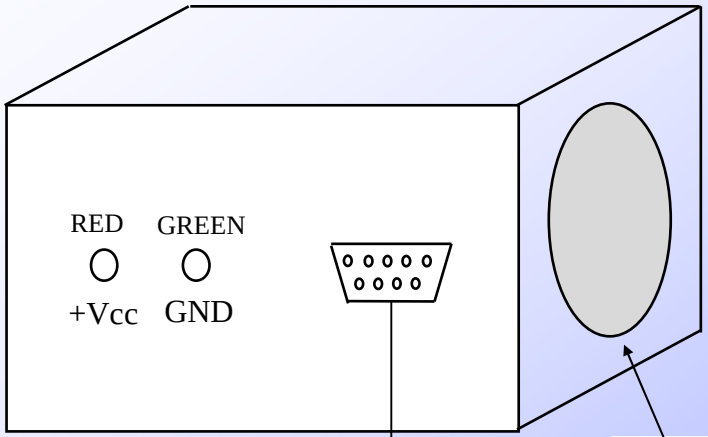
These are the different ranges that have been determined attending to the specifications of the project. The following table has been calculated taken the whole range of the green window and dividing it by six levels. Giving a margin of amber of 50 mm at both sides of each green level.

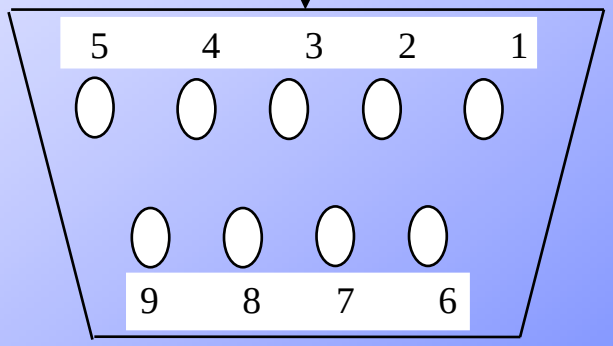
yellow 1	green 1	green 2	yellow 2
450	500	575	625
567	617	692	742
685	735	810	860
848	898	973	1023
1011	1061	1136	1186
1175	1225	1300	1350

Main window

Technical Details of the Project

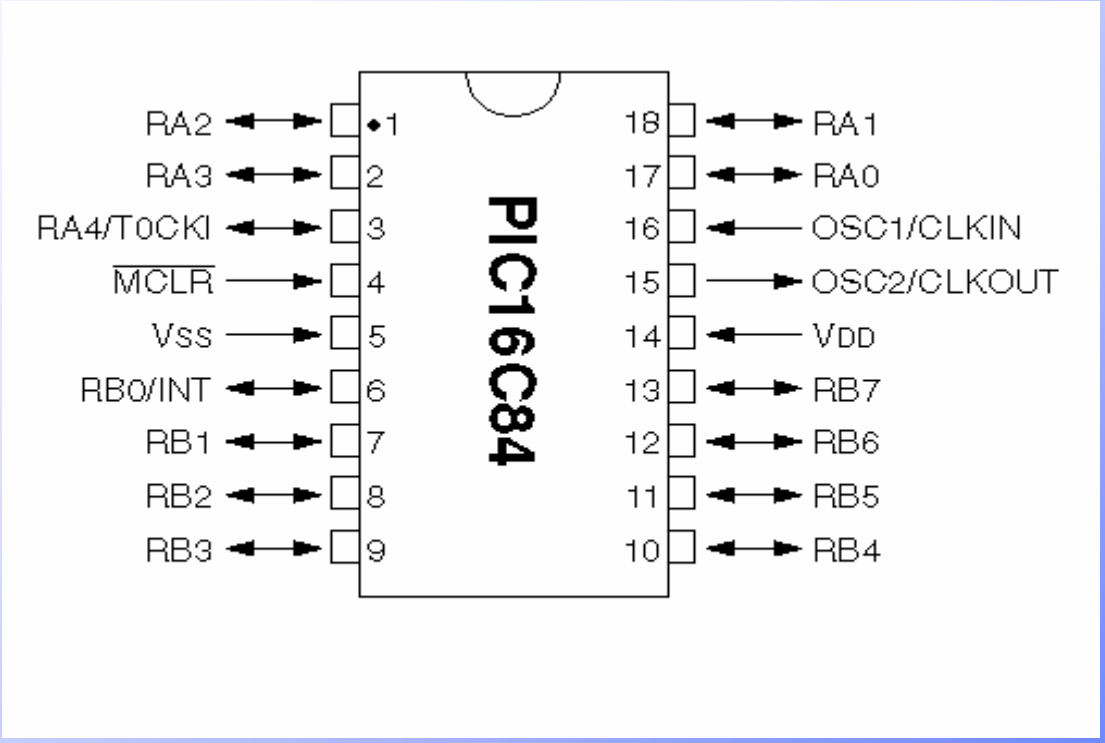
- **The Sensor (Polaroid's ultrasonic sensor)**



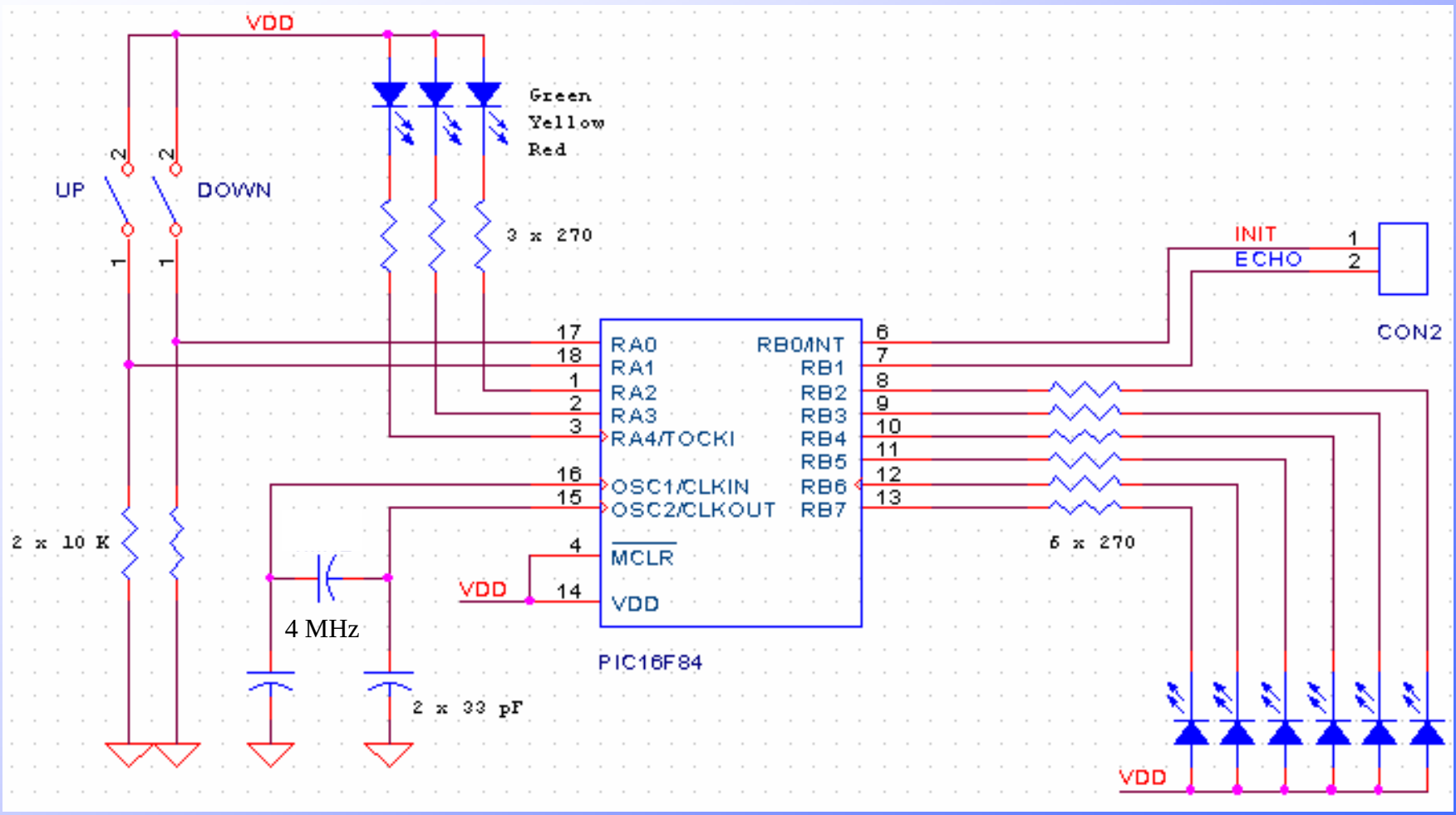


PIN 1 -GND
PIN 2 -NC
PIN 3 -NC
PIN 4 -ECHO
PIN 5 -+VCC
PIN 6 -NC
PIN 7 -INIT
PIN 8 -OSC
PIN 9 -NC

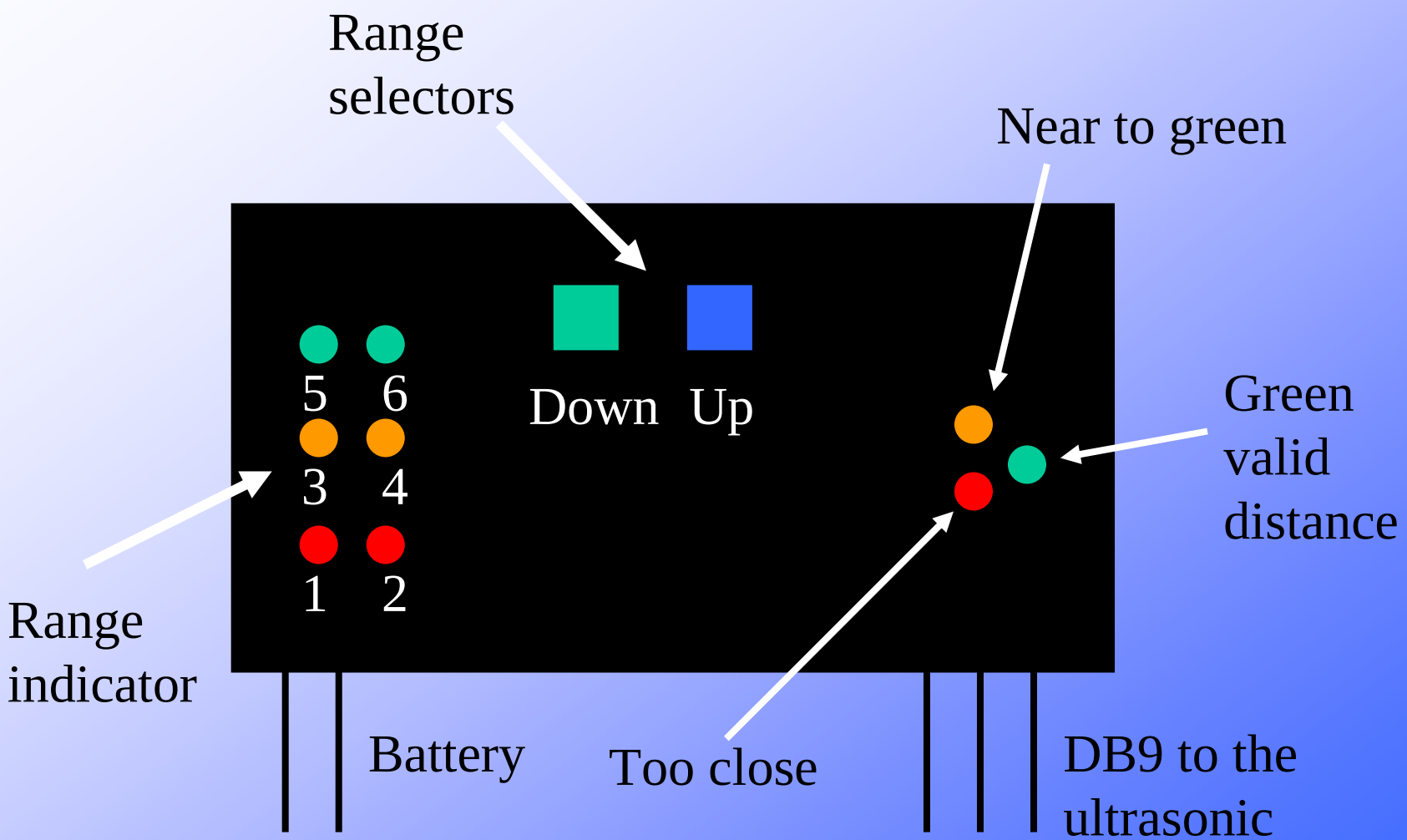
- **The Microcontroller**



- **Circuit designed for this Application**



- **The description of the built prototype**



- **The program**

The program basically has to deal with the signals coming from the ultrasonic ranging unit and process them.

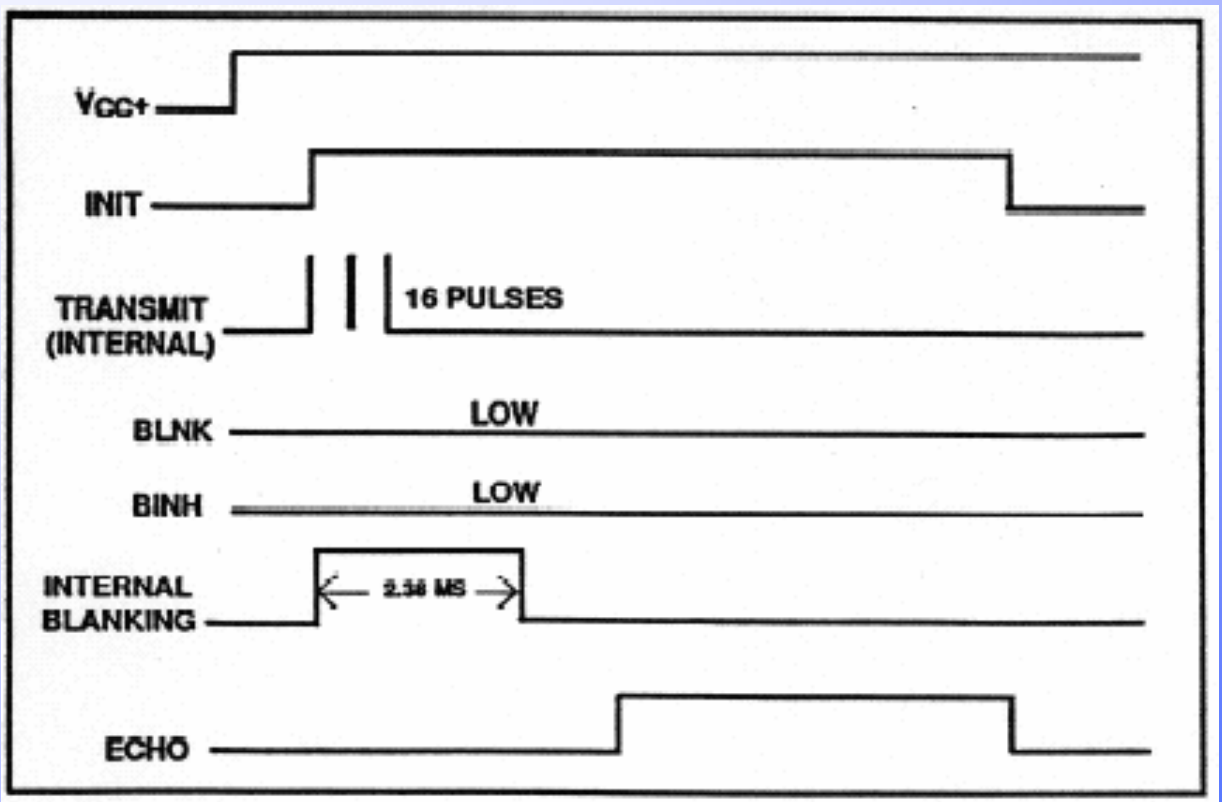


FIGURE 1: EXAMPLE OF A SINGLE-ECHO-MODE CYCLE WITHOUT BLANKING INPUT

The structure of the program can be resume in three different parts:

1. General loop .

- *Variable declarations*
- *Configuration of input/output ports*
- *Configuration of interrupts*
- *Variables definitions*
- *Main loop*

2. ECHO signal reception.

This piece of software code is executed through a routine, when a signal is received in pin PB0. It makes the following functions:

- *Capture the actual timer value*
- *Check the time against the limits*
- *Turn on the LED depending upon the distance measured*

3. Timer 0

Timer 0 interrupt will only be produced if there is no vehicle or if it is out of range. Just two simple actions are performed by this function:

- *Turn off the distance LED's .*
- *Control next measure .*

4. Other routines

There are several routines not commented in the other sections which performs different operations in the program :

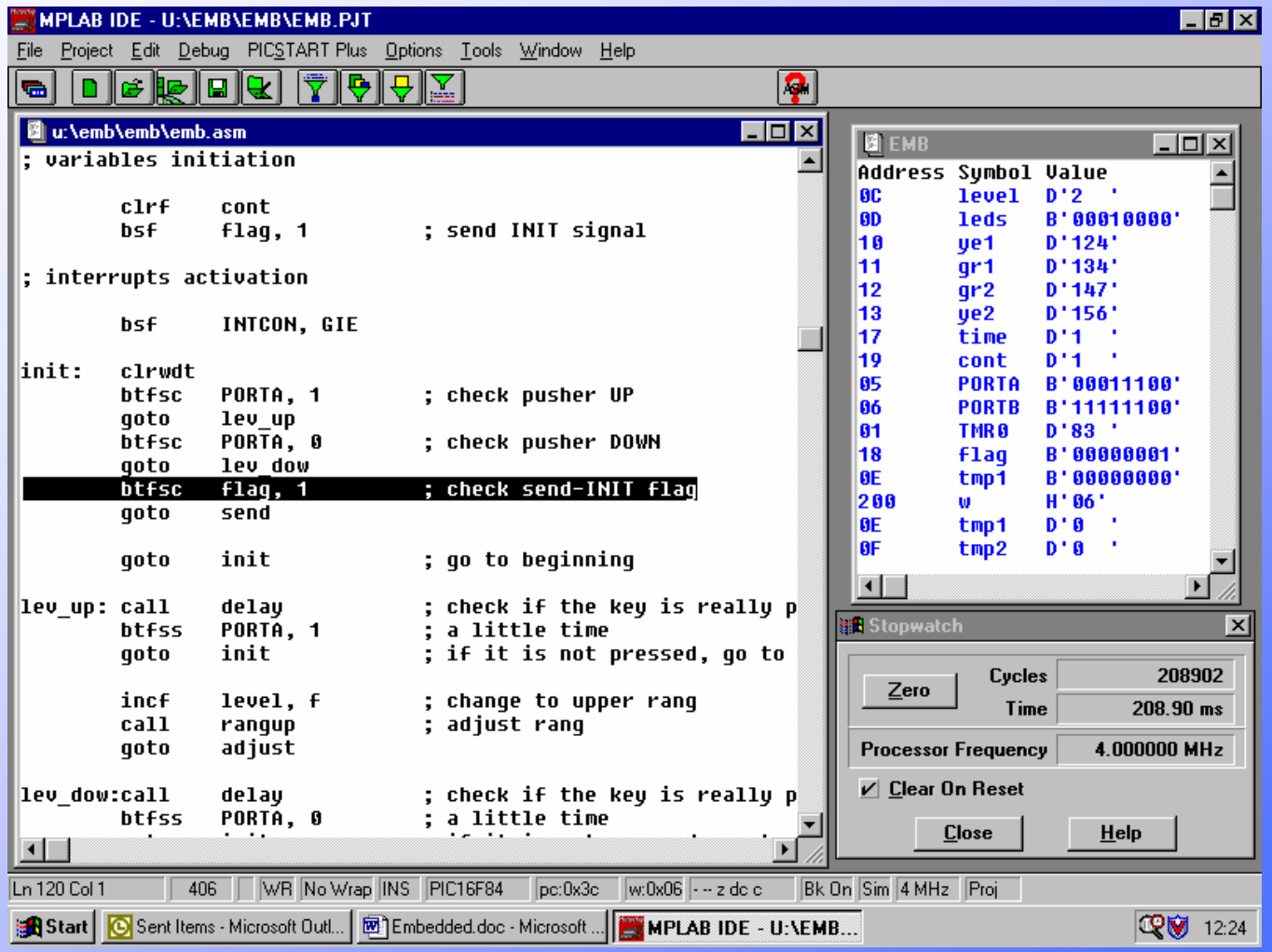
- *Limits*
- *Rangeup-Rangedo*
- *Delay* (delay of 15 ms)
- *Del100* (delay of 100 ms)
- *Wat100* (delay of 100 ms)

- **The Cost of this project**

COMPONENT	PRICE	QUANTITY	TOTAL
PIC16F84A	£3.39	1	£3.39
L78M05CV	£0.41	1	£0.41
LED's (red)	£0.07	7	£0.49
LED's (amber)	£0.07	1	£0.07
LED's (green)	£0.07	1	£0.07
Crystal 4 Mhz	£0.41	1	£0.41
Resistance (270)	£0.01	9	£0.09
Resistance (10 K)	£0.01	2	£0.02
Capacitor (33 pF)	£0.05	2	£0.10
Push switches	£0.41	2	£0.82
Battery connector	£0.41	1	£0.41
9-Way connector (male)	£0.50	1	£0.50
Socket (18 pins)	£0.16	1	£0.16
Copper-clad board	£1.26	1	£1.26
Box	£1.69	1	£1.69
TOTAL			£9.89

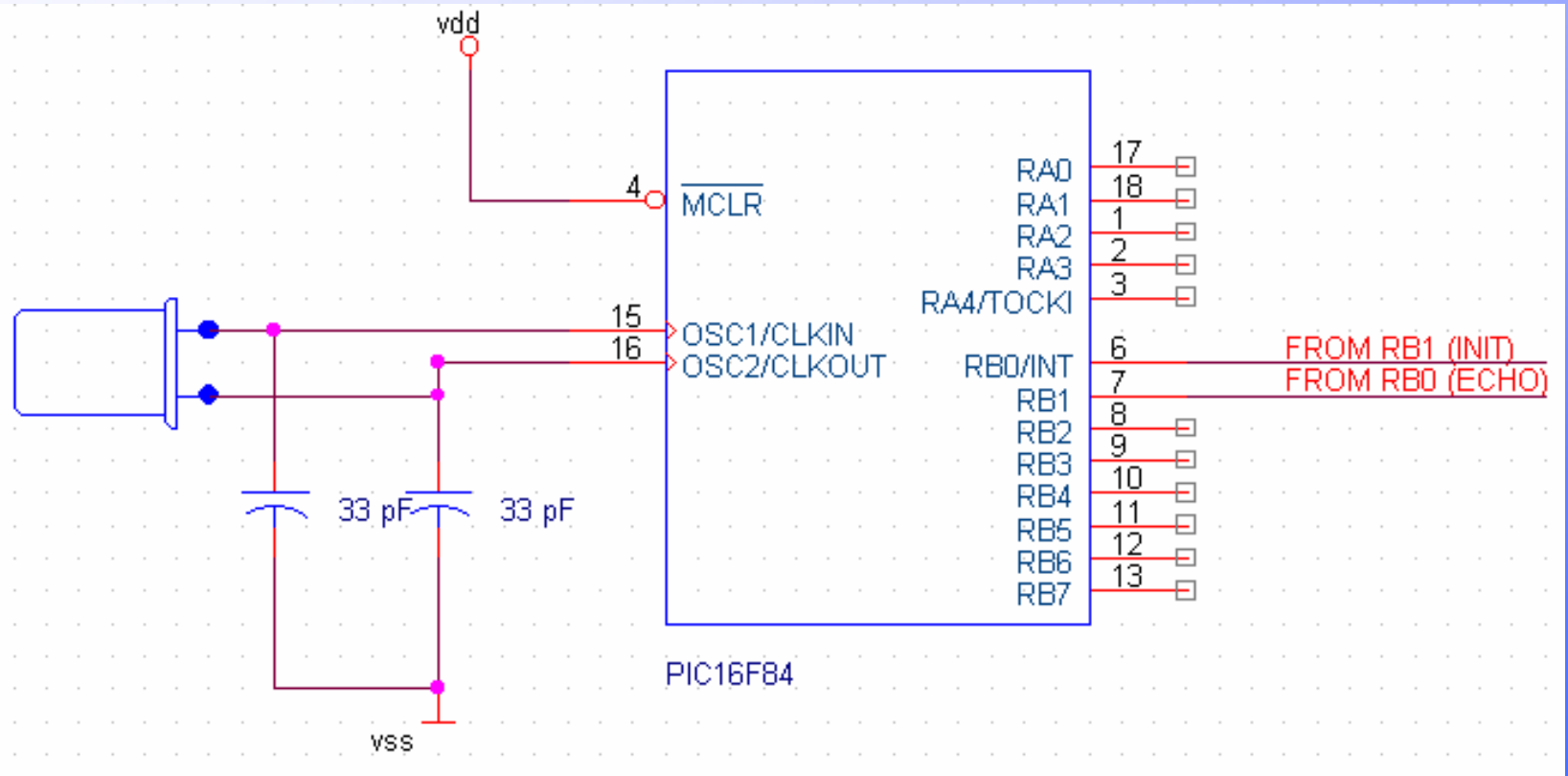
Simulation and experimental Results

- **The software simulation**



- **The hardware simulation**

1. Test circuit. Circuit simulating the functions of the ultrasonic connected to the prototype built.



2. Physical results with the ultrasonic and the prototype.

The following values were measured for the three first ranges levels including the main green window, all the values are in mm:

yellow 1	green 1	green 2	yellow 2
435	485	555	610
550	600	675	725
665	720	790	860

← Main window

They can be compared with the theoretical values the range levels:

yellow 1	green 1	green 2	yellow 2
450	500	575	625
567	617	692	742
685	735	810	860
848	898	973	1023
1011	1061	1136	1186
1175	1225	1300	1350

← Main window

Conclusions

In measuring the distances, some differences were detected between the calculated values and the measured values due to the construction of the sensor, since the sensor is not built up exactly at the end of the container. These measures were corrected during the test, achieving again the desired accuracy.

As possible improvements, it could be possible to use another microcontroller, as the P16F876, and implement more ranges using CAD's and potentiometers, and realise the measure using the counter implemented in this microcontroller.