Blind-Spot Collision Warning System

Design Review

ECE 445, Spring 2005

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Objective

Changing lanes can be very hazardous on a busy highway. There is region called "blind spot" which is a problem for every car driver since it's not covered by the driver's mirrors. Relying solely on the mirrors while changing lane can lead to a collision with another vehicle. Our design mitigates this situation by ensuring that the blind spots of the vehicle are clear prior to the driver attempt to change lanes.

Our design incorporates the need for detection and warning of objects present within the blind spot on either side of the vehicle to the driver along with distance measurement of the object relative to the vehicle, incase the driver decides to change lanes.

In our design, we will not use big scales used for a real car. Instead, we will use small scales arranged for a miniature car and show our results by using this miniature car. But, of course the range of the sensors can be adjusted so that they can be used in real cars.

Benefits

- Warn the driver of the presence of an object within the blind spot of the vehicle when the driver gives the turn signal for a lane change.
- Provide measurements of the object's distance relative to the vehicle to the driver.
- Will decrease the probability of an accident occurring due to any reason related to blind-spot
- Will help the driver focus on road by taking care of the blind spot region.

Features

- The device will notify the driver of any obstacles present in the blind-spot.
- The device will only notify the driver when the turn signal is activated.
- The device will alert the driver of any malfunctions.
- The device will conform to FCC regulations.
- The device should withstand typical weather conditions.
- The device will not significantly alter the outward appearance of the vehicle.

System Block Diagram

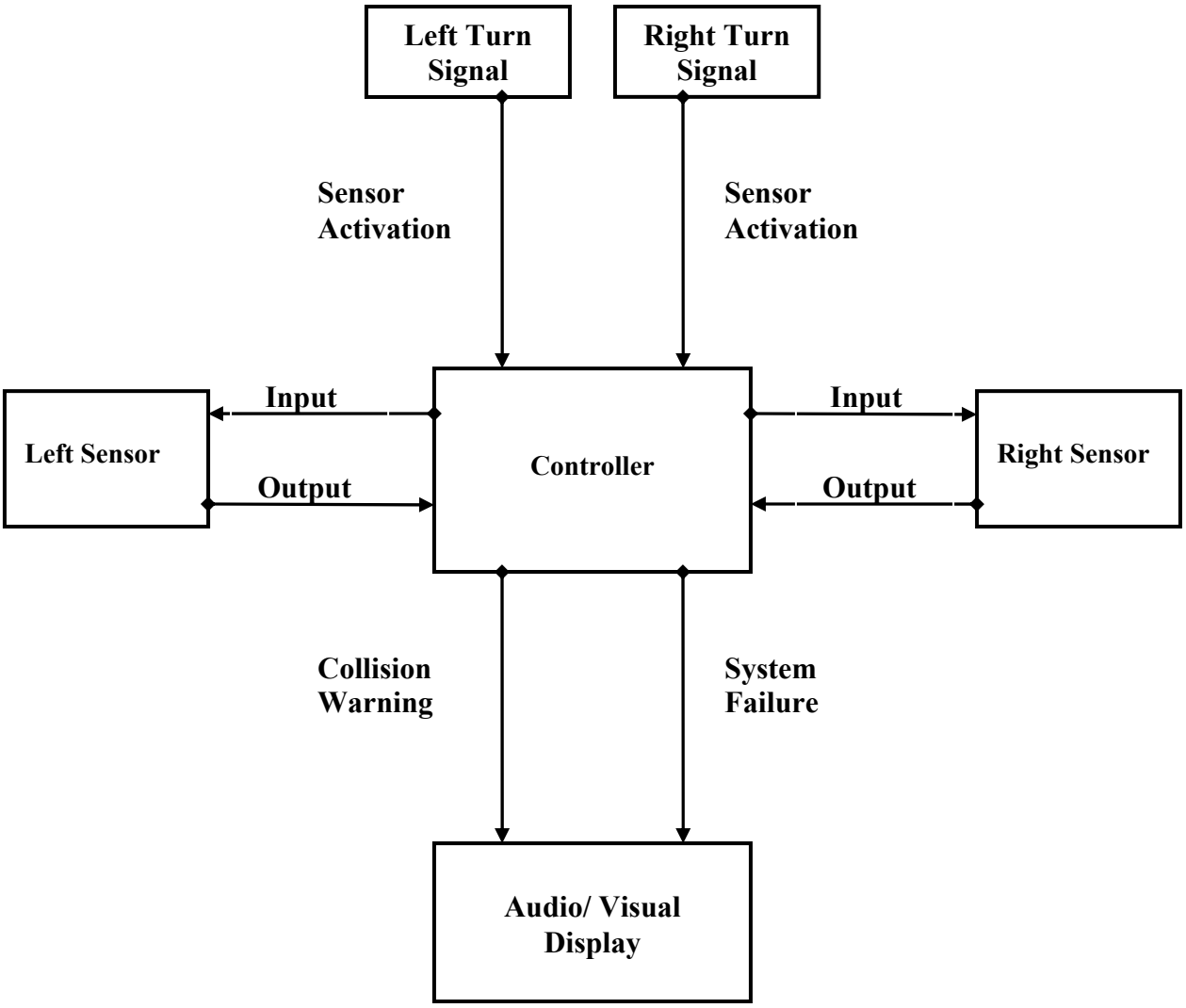
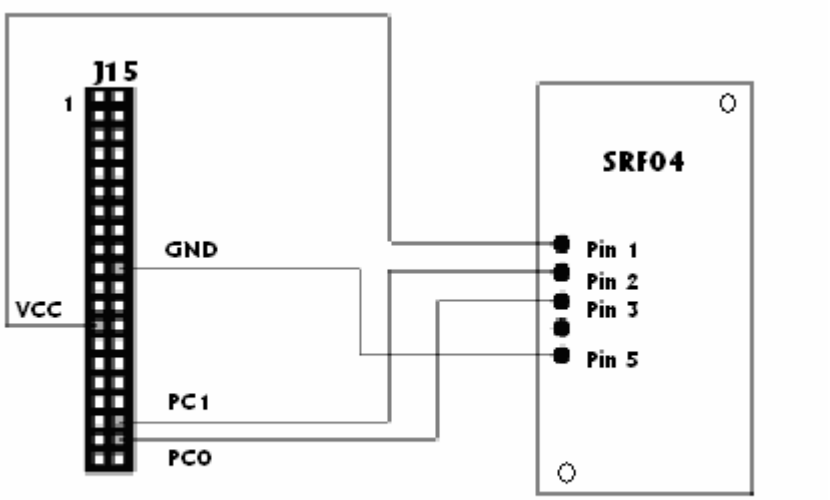


Figure: Blind-Spot Collision Warning System

Ultrasonic Sensor - SRF04

Overview:

- Inputs:
  - VCC (Pin1)
  - Trigger pulse input (Pin3)
  - Ground (Pin5)
- Outputs
  - Echo pulse output (Pin2)

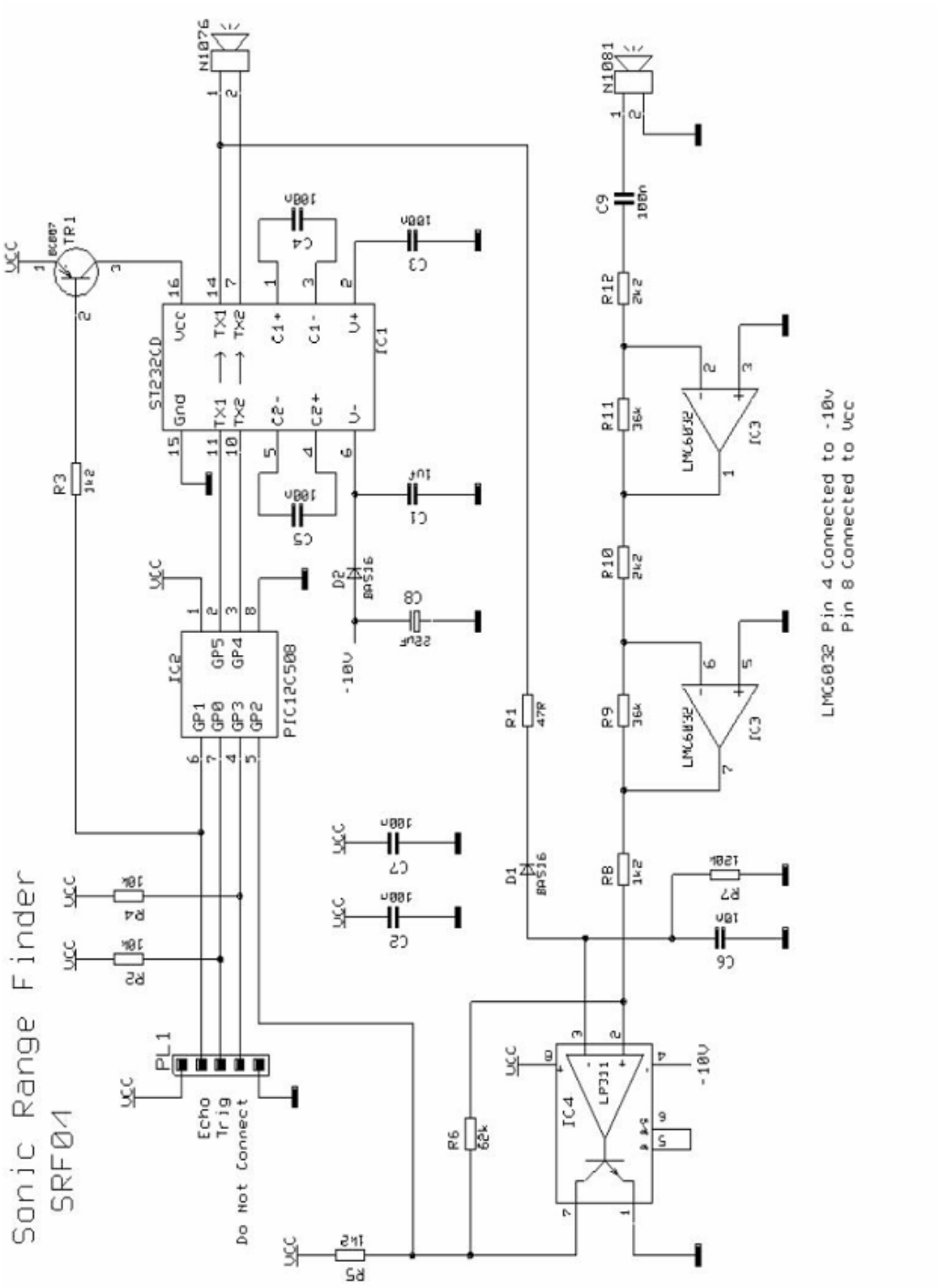


* PC1 and PC0 shown above are the input and output of controller chip **PIC16F877** respectively.

Specifications

Voltage	5V
Current	30mA Typ. 50mA Max
Frequency	40 KHz
Maximum range	6 m
Minimum range	3 cm
Sensitivity	Detect a 3cm diameter stick at > 2 m
Input trigger	10uS Min. TTL level pulse
Echo pulse	Positive TTL level signal, width proportional to range
Weight	0.4 oz.
Size	1.75" w x 0.625" h x 0.5" d

Figure: Sensor Schematic



Description of Operation:

The ranger works by transmitting a pulse of sound outside the range of human hearing. This pulse travels at the speed of sound (roughly 0.9 ft/msec) away from the ranger in a cone shape and the sound reflects back to the ranger from any object in the path of this sonic wave. The ranger pauses for a brief interval after the sound is transmitted and then awaits the reflected sound in the form of an echo. The controller driving the ranger requests a ping, and the ranger creates the sound pulse, and waits for the return echo. If received, the ranger reports this echo to the controller and the controller can then compute the distance to the object based on the elapsed time.

There are a couple of requirements for the input trigger and output pulse generated by the ranger. The input line should be held low (logic 0) and then brought high for a minimum of 10usec to initiate the sonic pulse. The pulse is generated on the falling edge of this input trigger. The ranger's receive circuitry is held in a short blanking interval of 100usec to avoid noise from the initial ping and then it is enabled to listen for the echo. The echo line is low until the receive circuitry is enabled. Once the receive circuitry is enabled, the falling edge of the echo line signals either an echo detection or the timeout (if no object echo is detected).The controller will want to begin timing the falling edge of your trigger input and end timing on the falling edge of the echo line. This duration determines the distance to the first object the echo is received from.

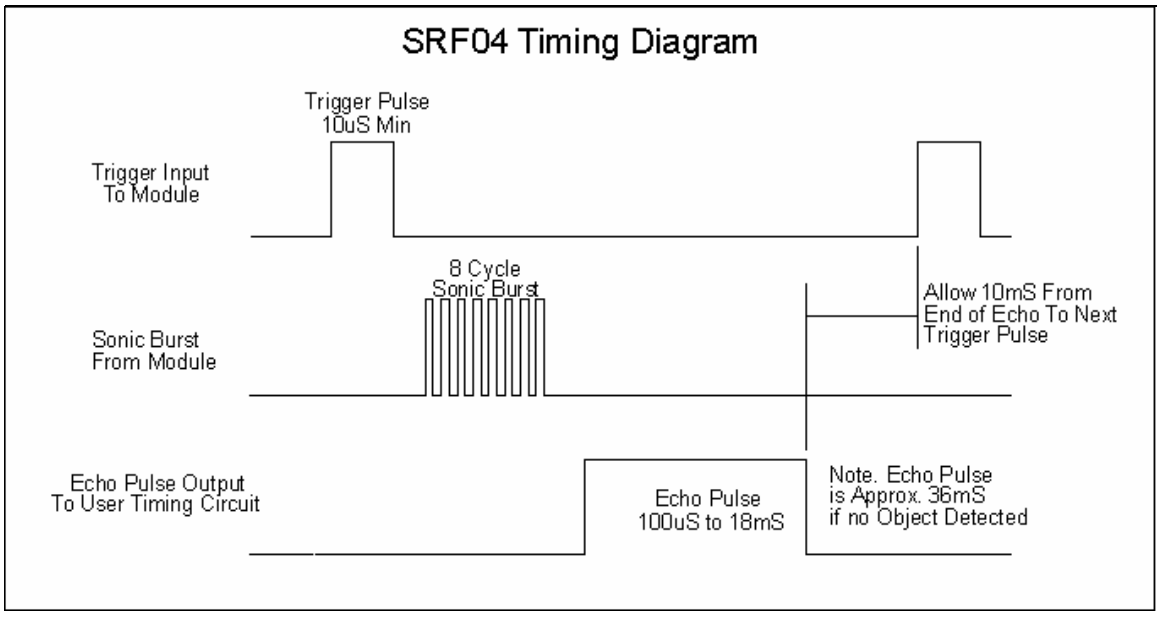


Figure: Beam Pattern

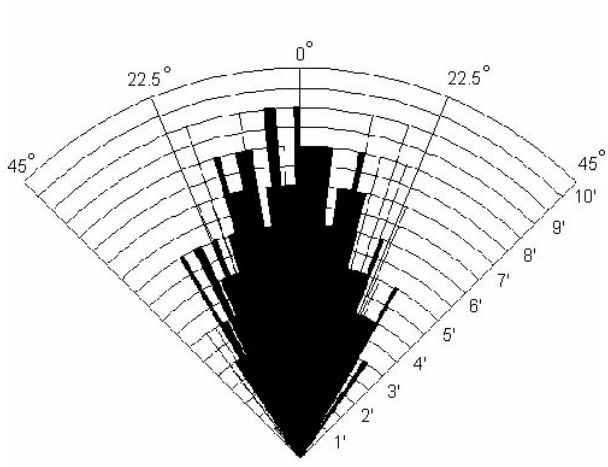
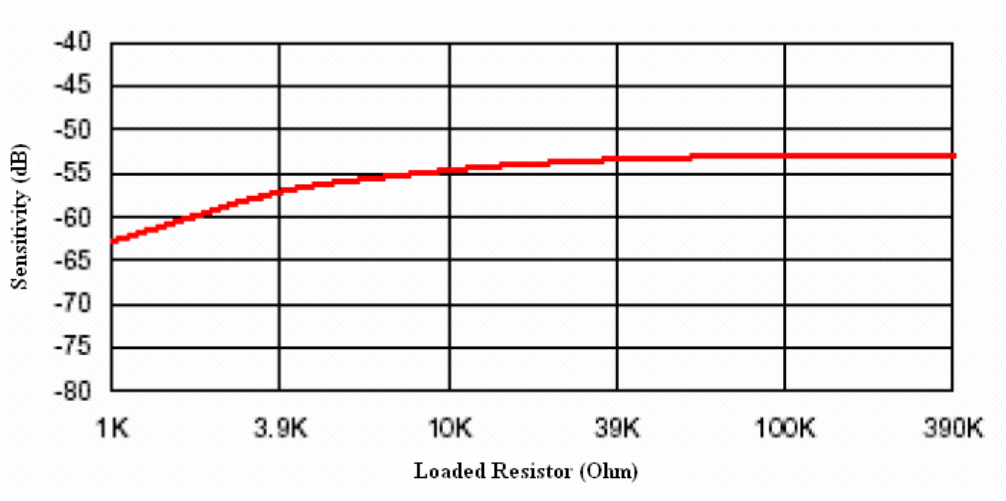
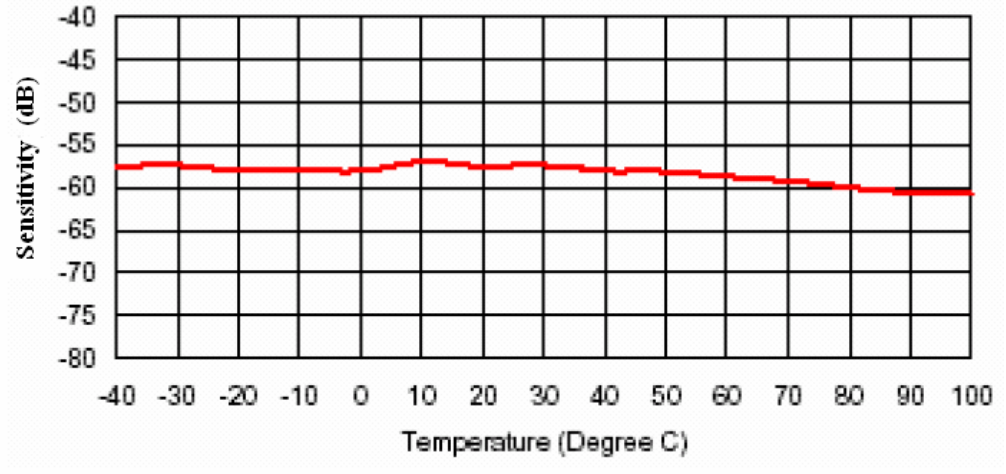


Figure: Tolerance Analysis;



Sensitivity Variation vs. Loaded Resistor



Sensitivity vs. Temperature

Crystal Oscillator-MC12061P

Overview:

- Inputs:
  - VCC (Pin1, Pin11, Pin16)
  - VEE (Pin8, Pin9)

- Outputs
  - Complementary Sine Wave (600 mVpp typ) (Pin2, Pin3)
  - Complementary MECL (Pin 12, Pin 13)
  - Single Ended TTL (Pin 10)

Figure: MC12061 Oscillator Circuit

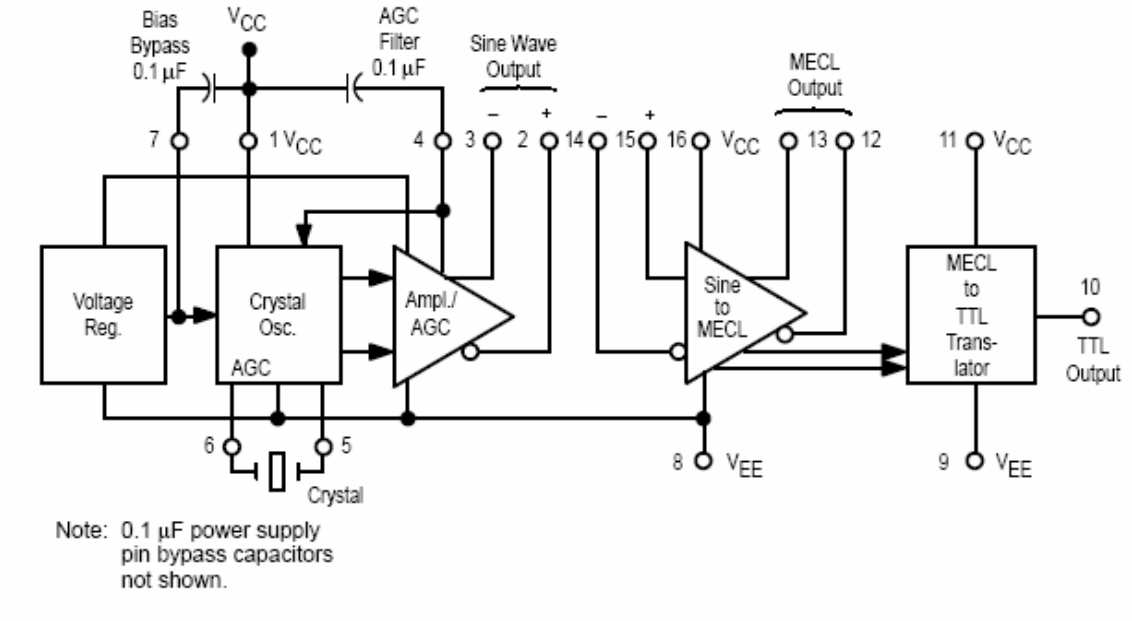


Table: Technical Specifications

Characteristic	**MC12061**
Mode of Operation	Fundamental Series Resonance
Frequency Range	2.0 MHz – 20 MHz
Series Resistance, R1	Minimum at Fundamental
Maximum Effective Resistance, RE (MAX)	155 Ohms
Temperature Range	0 to + 70°C
Single Supply Operation	+5.0 Vdc or –5.2 Vdc

Description of Operation:

The MC12061 is for use with an external crystal to form a crystal controlled oscillator. In addition to the fundamental series mode crystal, two bypass capacitors are required (plus usual power supply pin bypass capacitors). Translators are provided internally for MECL and TTL outputs. We will use TTL output for our design.

Typical Circuit Configurations for Oscillator;

Note: 0.1 µF power supply pin bypass capacitors not shown.

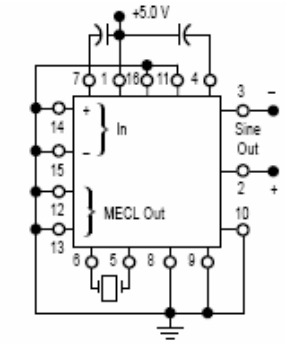


Figure A. Sine Wave Output

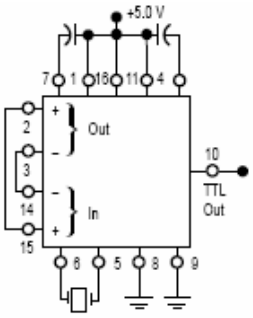


Figure B. MTTL Output

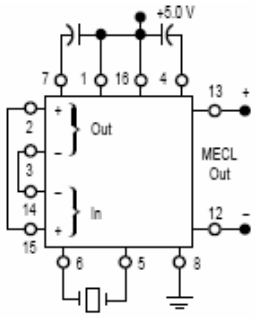


Figure C. MECL Output (+5.0 V Supply)

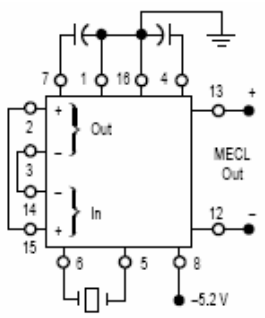


Figure D. MECL Output (-5.2 V Supply)

Four Digit Display Decoder/ Driver

Overview:

The Maxim ICM211 (LCD) four digit, seven segment display driver consists of:

- Inputs:
  - Four BCD data inputs (Pins 27-30)
  - Four separate digit strobes (Pins 31-34)
  - Oscillator input (Pin 36)
  - Brightness Input for LED display/ blank display (Pin 5)
  - Operating Supply voltage (Pin 1)
  - Ground (Pin 35)
- Outputs
  - Seven segment outputs per digit giving a total of 28 open drain constant current outputs. (Remaining Pins)

Figure: Pin Layout

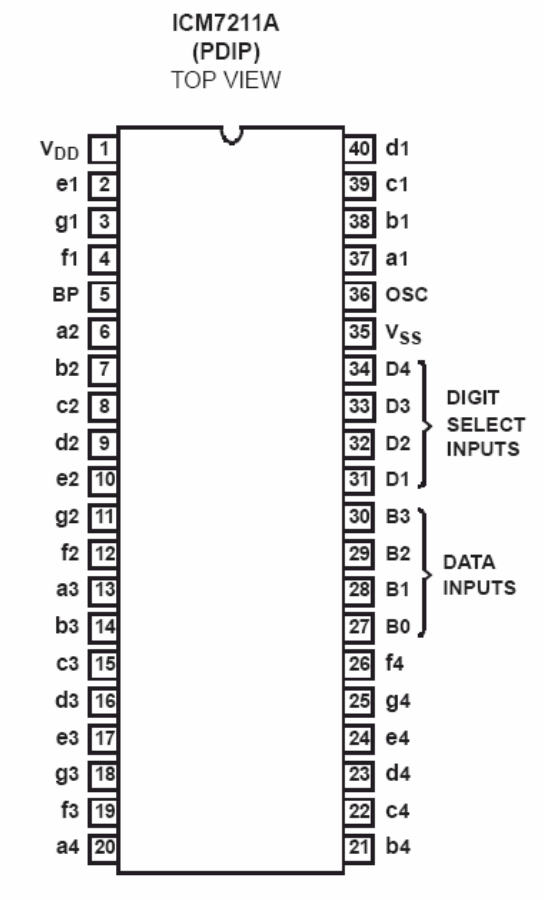


Figure: PIN Input Definitions

Input Definitions In this table, V_{DD} and V_{SS} are considered to be normal operating input logic levels. Actual input low and high levels are specified under Operating Characteristics. For lowest power consumption, input signals should swing over the full supply.

INPUT	DIP TERMINAL	CONDITIONS	FUNCTION	
B0	27	V_{DD} = Logical One V_{SS} = Logical Zero	Ones (Least Significant)	Data Input Bits
B1	28	V_{DD} = Logical One V_{SS} = Logical Zero	Twos	
B2	29	V_{DD} = Logical One V_{SS} = Logical Zero	Fours	
B3	30	V_{DD} = Logical One V_{SS} = Logical Zero	Eights (Most Significant)	
OSC	36	Floating or with External Capacitor to V_{DD}	Oscillator Input	
		V_{SS}	Disables BP output devices, allowing segments to be synchronized to an external signal input at the BP terminal (Pin 5).	

Multiplexed-Binary Input Configuration

INPUT	TERMINAL	CONDITIONS	FUNCTION
D1	31	V_{DD} = Active V_{SS} = Inactive	D1 Digit Select (Least Significant)
D2	32		D2 Digit Select
D3	33		D3 Digit Select
D4	34		D4 Digit Select (Most Significant)

Description of Operation:

The ICM7211A provides outputs suitable for driving conventional four-digit, seven-segment LCD displays.

- Connect the V_{DD} and V_{SS}
- Connect the OSC input to V_{DD}
- Connect the desired four-bit true binary input at pins 27 thru 30, least significant bit at pin 27 ascending to the most significant bit at pin 30. It decodes the binary input into seven-segment alphanumeric “Code B” output, i.e., 0-9, dash, E, H, L, P, and blank (See table below)
- The binary input is decoded to seven-segment decimal output (See Figure below)
- These devices provide four separate digit lines (least significant digit at pin 31 ascending to most significant digit at pin 34), each of which when taken to a positive level decodes and stores in the output latches of its respective digit the character corresponding to the data at the input port, pins 27 through 30.

Table: Output Codes

BINARY				CODE B ICM7211A ICM7212AM
B3	B2	B1	BO	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	-
1	0	1	1	E
1	1	0	0	H
1	1	0	1	L
1	1	1	0	P
1	1	1	1	BLANK

Figure: Segment Assignment

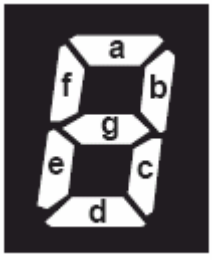


Figure: Functional Block Diagram

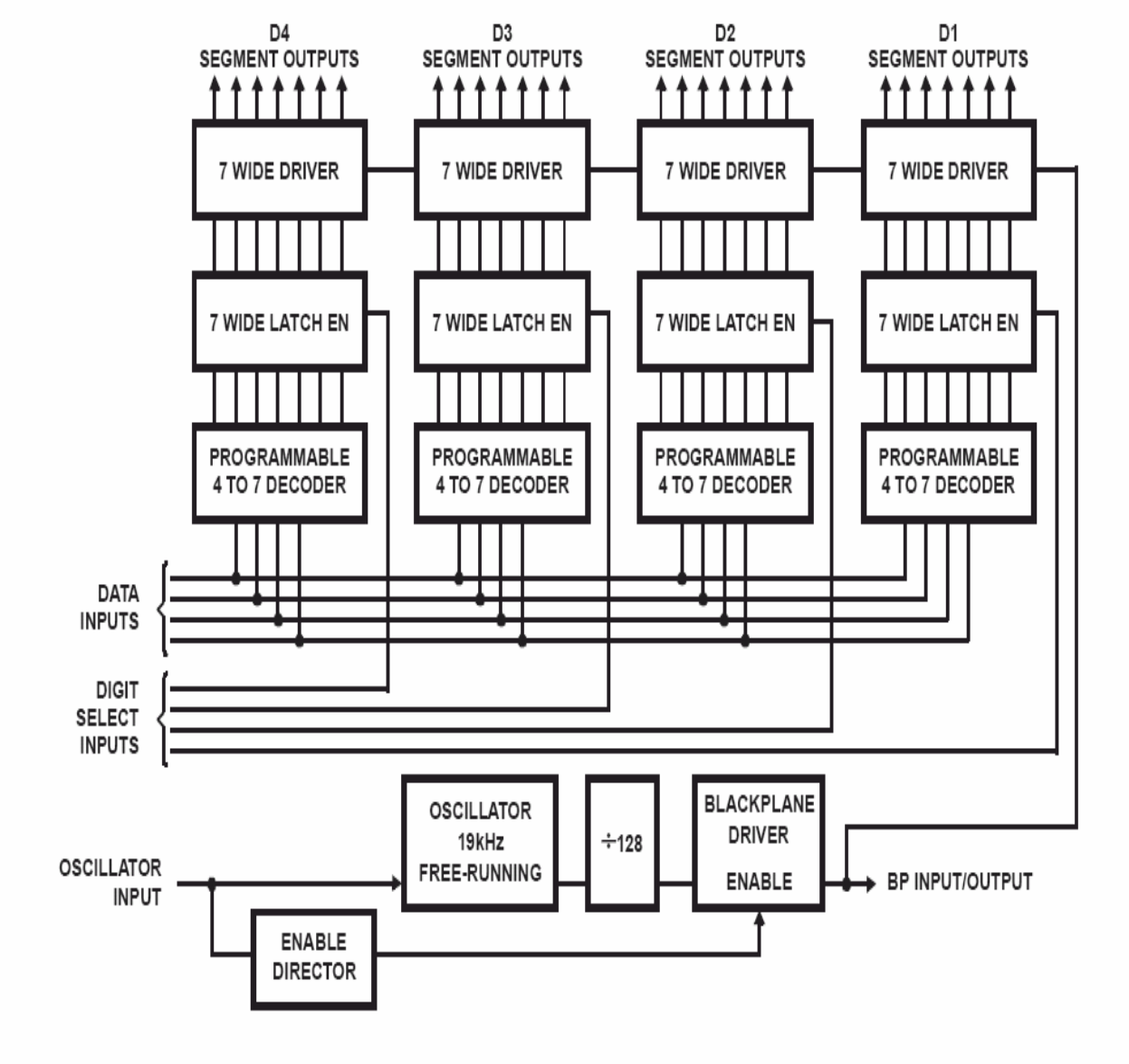
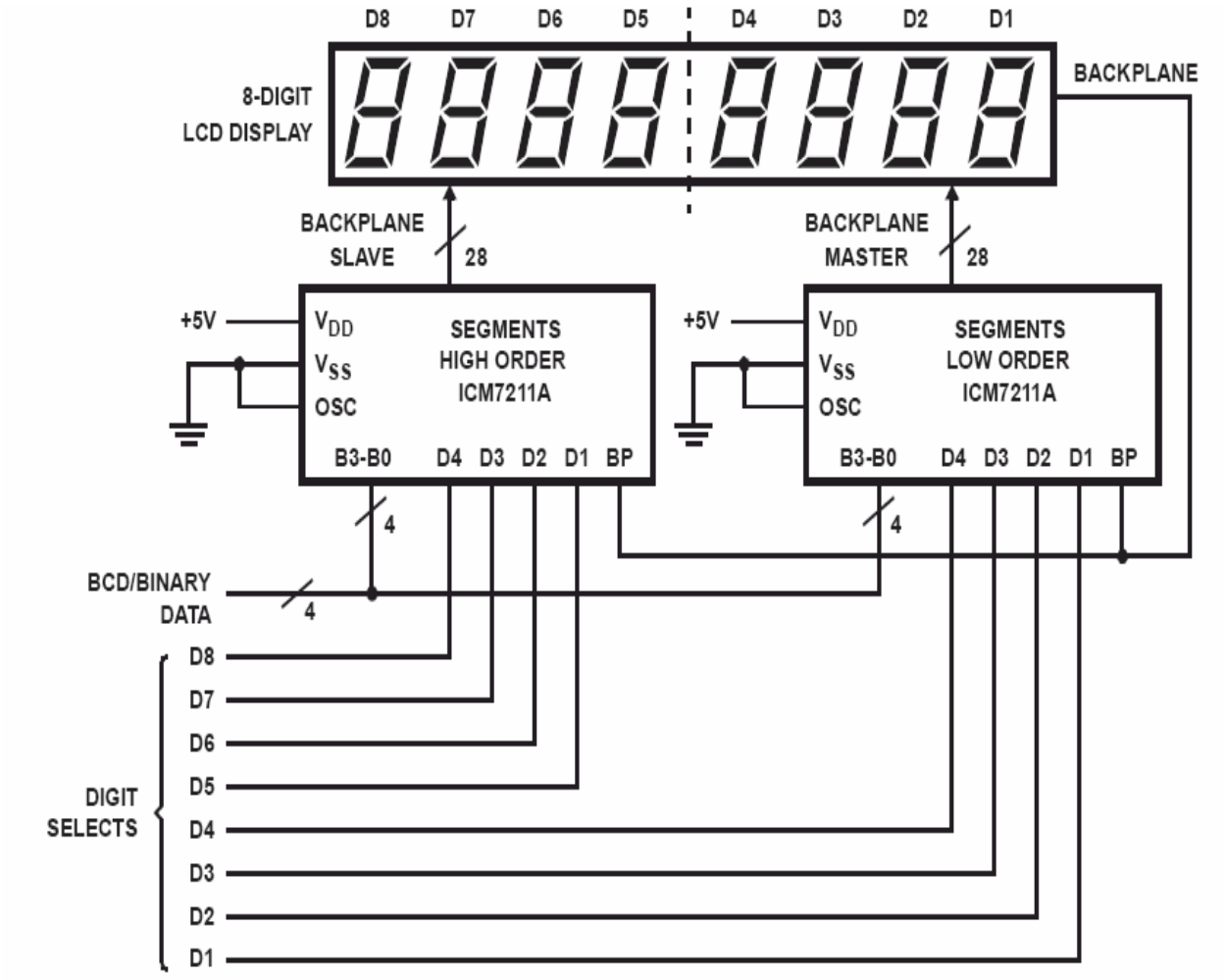


Figure: Ganged ICM7211A's driving 8-digit LCD display



Technical Specifications

Absolute Maximum Ratings

Supply Voltage (V_{DD} - V_{SS}) 6.5V
Input Voltage (Any Terminal) (Note 1) . . V_{SS} - 0.3V to V_{DD}, + 0.3V

Operating Conditions

Temperature Range . . . . . -40×°C to 85°C

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} (°C/W)
PDIP Package	60
MQFP Package	80

Maximum Junction Temperature . . . . . 150°C
Maximum Storage Temperature Range . . . . . -65×°C to 150°C
Maximum Lead Temperature (Soldering, 10s) . . . . . 300°C
(MQFP - Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Due to the SCR structure inherent in the CMOS process, connecting any terminal to voltages greater than V_{DD} or less than V_{SS} may cause destructive device latchup. For this reason, it is recommended that no inputs from external sources not operating on the same power supply be applied to the device before its supply is established, and that in multiple supply systems, the supply to the ICM7211A be turned on first.
2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CHARACTERISTICS (LCD) V_{DD} = 5V ±10%, T_A = 25°C, V_{SS} = 0V Unless Otherwise Specified					
Operating Supply Voltage Range (V_{DD} - V_{SS}), V_{SUPPLY}		3	5	6	V
Operating Current, I_{DD}	Test circuit, Display blank	-	10	50	µA
Oscillator Input Current, I_{OSCI}	Pin 36	-	±2	±10	µA
Segment Rise/Fall Time, t_r, t_f	C_L = 200pF	-	0.5	-	µs
Backplane Rise/Fall Time, t_r, t_f	C_L = 5000pF	-	1.5	-	µs
Oscillator Frequency, f_{OSC}	Pin 36 Floating	-	19	-	kHz
Backplane Frequency, f_{BP}	Pin 36 Floating	-	150	-	Hz
INPUT CHARACTERISTICS					
Logical "1" Input Voltage, V_{IH}		4	-	-	V
Logical "0" Input Voltage, V_{IL}		-	-	1	V
Input Leakage Current, I_{ILK}	Pins 27-34	-	±0.01	±1	µA
Input Capacitance, C_{IN}	Pins 27-34	-	5		pF
BP/Brightness Input Leakage, I_{BPLK}	Measured at Pin 5 with Pin 36 at V_{SS}	-	±0.01	±1	µA
BP/Brightness Input Capacitance, C_{BPI}	All Devices	-	200	-	pF
AC CHARACTERISTICS - MULTIPLEXED INPUT CONFIGURATION					
Digit Select Active Pulse Width, t_{WH}	Refer to Timing Diagrams	1	-	-	µs
Data Setup Time, t_{DS}		500	-	-	ns
Data Hold Time, t_{DH}		200	-	-	ns
Inter-Digit Select Time, t_{IDS}		2	-	-	µs
AC CHARACTERISTICS - MICROPROCESSOR INTERFACE					
Chip Select Active Pulse Width, t_{WL}	Other Chip Select Either Held Active, or Both Driven Together	200	-	-	ns
Data Setup Time, t_{DS}		100	-	-	ns
Data Hold Time, t_{DH}		10	0	-	ns
Inter-Chip Select Time, t_{ICS}		2	-	-	µs

3 ½ Digit LCD Display

Description:

The LCD display directly interfaces with the Four Digit Display Decoder/ Driver. Since the distance result will be displayed in centimeters, and the maximum sensor range is 3 meters = 300 centimeters, we only require a 3 digit display. The first three seven-segment outputs (D1-D3) from the decoder are directly fed to the LCD display module

Table: Technical Specifications

Electrical Characteristics

Item	Min	Type	Max	Unit
Operating Voltage (rms)	3	5	6	V
Operating Frequency		32		Hz
Supply Current		8	25	µA
Operating Temperature	-30		80	°C

Pin Description

Pin	Com	Pin	Com	Pin	Com	Pin	Com
1	COM	11	2C	21	4A	31	2F
2	Y	12	2P	22	4F	32	2G
3	1BC	13	3E	23	4G	33	NC
4	NC	14	3D	24	3B	34	NC
5	NC	15	3C	25	3A	35	NC
6	NC	16	3P	26	3F	36	NC
7	NC	17	4E	27	3G	37	NC
8	1P	18	4D	28	COL	38	LOBAT
9	2E	19	4C	29	2B	39	X
10	2D	20	4B	30	2A	40	COM

Figure: Pin Layout

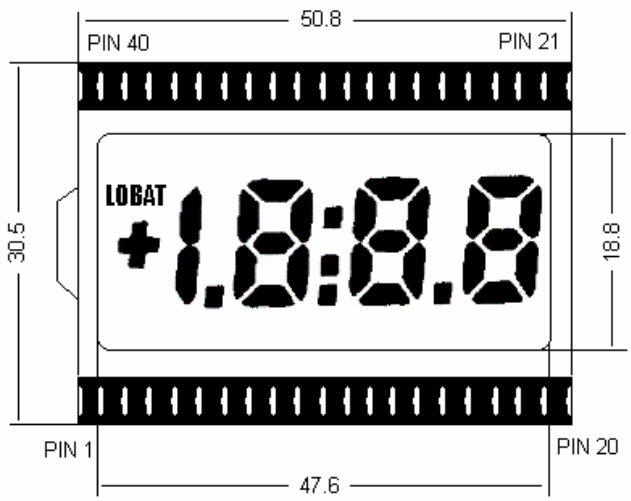
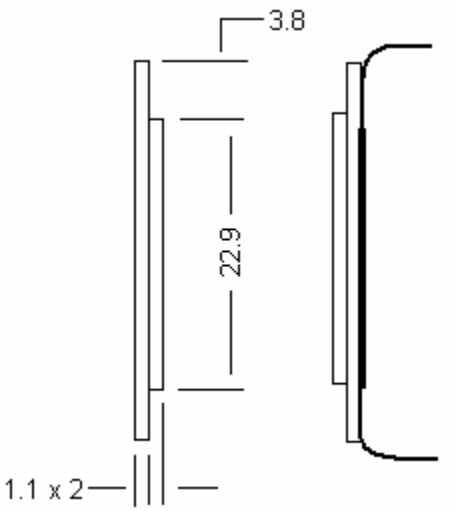


Figure: Dimensions (in nm)



PICS MICROCONTROLLER

Figure: 40-Pin PDIP PIC16F877A Microcontroller

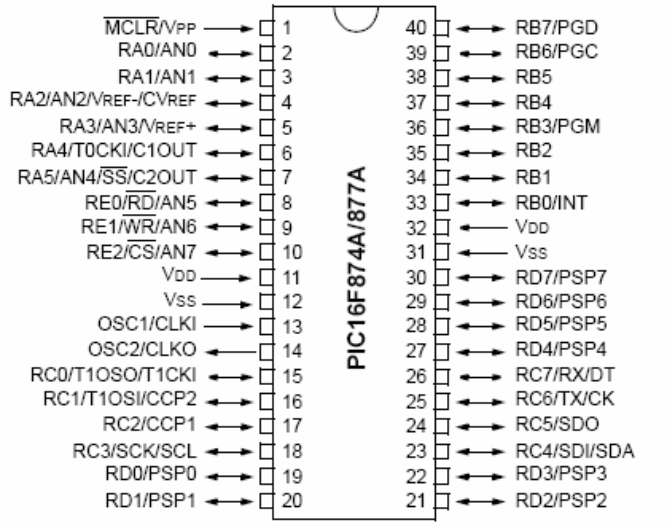


Table: Technical Specifications

Key Features	PIC16F877A
Operating Frequency	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	8K
Data Memory (bytes)	368
EEPROM Data Memory (bytes)	256
Interrupts	15
I/O Ports	Ports A, B, C, D, E
Timers	3
Capture/Compare/PWM modules	2
Serial Communications	MSSP, USART
Parallel Communications	PSP
10-bit Analog-to-Digital Module	8 input channels
Analog Comparators	2
Instruction Set	35 Instructions
Packages	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

Cost Analysis

Each of us will work 8 hours per week for 14 weeks this semester = 112 hours per person per semester.
Desired pay = $ 20 per hour per person.
Total labor cost = $ 20 * 112 * 2*2.5 = $ 11200

Qty	Part #	Description	Status	Unit Price	Total Cost
1	PIC16F877A	PICS microcontroller	Part shop	$ 7.70	$ 7.70
1	MC12061	Oscillator (2-20MHz)	Part Shop	$ 2.50	$ 10.20
1		Oscillator Crystal	Part Shop	$ 0.96	$ 11.16
1	SRF04	Sensor Module	Ordered	$ 32.00	$ 43.16
1		Speaker	In Lab	$ 10.00	$ 53.16
1	ICM211	LCD Driver	Ordered	$ 2.87	$ 56.03
1		3½ Digit LCD Display	Ordered	$ 3.12	$ 59.15
1		Mysterious Hardware	Undecided	~$ 10.00	$ 69.15
2		0.1 uF Capacitor	Part shop	$ 0.10	$ 69.25

Grand Total: $ 11200 + $ 69.25 ≈ $ 11270

Schedule

Week of	Activity	Arslan	Talip
1/17	Project Ideas	Discuss ideas	Discuss ideas
1/24	Project Ideas	Discuss ideas	Discuss ideas
1/31	Proposal	Discuss design	Discuss design
2/7	Research parts	Controller	Sensor
2/14	Initial design	Review PICS programming	Study sensor data sheets
2/25	Design review	Gather parts	Order sensor
2/28	Receive parts/ start testing	Programming PICS module	Testing sensors on oscilloscope
3/7	More design and testing	Programming PICS module	Test speaker and LCD
3/14	Integration	Interface PICS with sensors	Interface PICS with sensors
3/21	Mockup demo	Interfacing & debugging	Interfacing & debugging
3/28	Testing	Modify design if needed	Modify design if needed
4/4	Testing continued	Interfacing & debugging	Interfacing & debugging
4/11	Finish Up	Check Controller connections	Check sensor and feedback module
4/18	Review	Final testing	Final testing
4/25	Demos	Demo	Demo
5/2	Final Paper	Finish write up	Review and modify write up
5/9	Check-out	Pizza!	Pizza!