ACOUSTIC NAVIGATION FOR MOBILE ROBOTS

Bi-Weekly Report

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CPSC 483
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Introduction

Our design project is going according to plan. We have already received all of the major parts and are working diligently on the final aspects of our design. Below is on outline of our status concerning different aspects of the design, as well as an update of our scheduling and new issues with our design.

Current Design

Figures 1, 2, and 3 illustrate our current design. We have decided to fabricate two separate printed circuit boards: one for the microphone array itself and one for the microcontroller. This will allow us more modularity and ease of maintenance and fabrication. The microphone array board will consist of the 8 microphones patterned in such a way that each microphone has 45^{o} of coverage. Further, the board will have a resistor pack that will develop the output signal for each microphone. We will route the signals to the microcontroller board via a 10-pin connector. The microcontroller prepares the microphone signal to be presented to the microprocessor of the Mark III. This board will accept the eight microphones data into an 8:1 multiplexer that is controlled by the Mark III's processor. Once a microphone is selected, it will be sent to the filter (LMF100). The filter has two inputs, one for the microphone data and one from the crystal and 4-bit counter (74LS191) circuit, which will provide 8 center frequencies through a processor controlled 8:1 multiplexer. After the filter, the signal's RMS value will be converted to DC, by Maxim-IC's MX536A, and be sent to the A/D converter (ADC0801). This will then convert the signal into an 8-bit value that will be sent to the processor. In all, we will be using 17 pins on the Mark III. Six bits will be used for the multiplexers, and eight bits will be used for the microphone signal. However, we also have the capability to send the microphone signal to the processor in analog format, as the processor has analog capabilities.

We have measured the amperage being given by our power supply to all of our components as 0.70 A.

RMS-to-DC Conversion

The last major hurdle in our design was the rectification and signal amplitude detection. We stumbled across several chips that will do an “automatic” RMS to DC conversion of an AC signal. The first IC that we found to generate this DC value from an AC signal had several problems that required us to find a substitute part. The sample that we received from Analog Devices was a surface mount IC, and, as such, would not be usable to our project. The PDIP package of this chip was also difficult to obtain, and would not have arrived within the prescribed amount of time left in the semester. We also had the option to use a variation of the part that we decided upon, but that part would have cost $30, much more than we would have liked to spend one small component. We then identified a similar product from Maxim-IC, the MX536A (Figure 4), and ordered samples. Their IC came packaged as a PDIP, and functioned similarly to the AD737 from Analog. We have tested the new IC, and it performs quite well.

Developing the PCB

We chose to use Protel Design Explorer 99 SE as our software design tool for developing our PCBs due to its wide acceptance and powerful functionality. Protel links schematic diagrams with PCB designs by means of footprints -- physical device specifications associated with a schematic part. For each IC, counter, header, resistor, and capacitor we used in our design, we specified a footprint and a pin out. Once we fully connected every route in our schematics, we specified the dimensions of our PCBs and defined the keep out areas and drills. Protel then placed each part in the PCB editing window for us to place. We then placed each component on the PCB in such a way that optimized route lengths and space consumption, which was aided by

Protel with a color indicator that shows optimal placements for components by analyzing its connections. Once every component was placed as desired, we defined our design rules, specifically the widths of the power traces and signal traces. We used the Protel autorouter to create our initial routes, and then added additional ground planes in the remaining exterior areas on both sides of the boards to shield noise. We then used the Protel CAM manager to produce our output gerber files and drill files required by our manufacturer, AP Circuits.

Programming The Mark III

Now that we have completed the design of our microprocessor and microphone array, we our working on our algorithm for the Mark III. As a test, we have loaded a line following program on the Mark III to demonstrate the basic idea of how the robot will respond to I/O lines. The line following program consists of 3 I/O lines that correspond to 3 different photo reflector sensors (left, center, right). The sensors respond to black and the servos are activated when the sensors detect it. Each sensor moves the left and right servos accordingly. The robot follows the black color until it is gone and then stops. The black color can represent our sound source for our design.

Our algorithm will consist of 8 I/O lines that correspond to each microphone. Once the program detects which microphone generates the biggest signal, our robot will go to the sound source. The robot will continue to move to the sound source unless it is turned off or has changed direction.

We are currently discussing other functionality features that we want to implement on our robot such as collision detection, forward and backwards movement, following a moving sound, and other such ideas. We want to show its full functionality in our final demo.

Order Status

We have received all our parts, except for the actual PCBs from AP Circuits. They should be shipped Tuesday, April 22, 2003, and arrive in our possession a day later. We also ordered, and received, 24 additional microphones. This will assure that we have as many microphones as we need, since our chosen microphones have been very fragile, breaking even with normal handling. Table 1 illustrates our current price breakdown.

Schedule/Future Plans

After we receive the PCBs, we will solder the parts onto the boards, to finish the hardware portion of our project. Now we have to focus on the software aspect of our design. This should be a relatively simple operation. The last things to be finished are our final demonstration and final report. The Gantt chart in Figure 5 illustrates our progress.

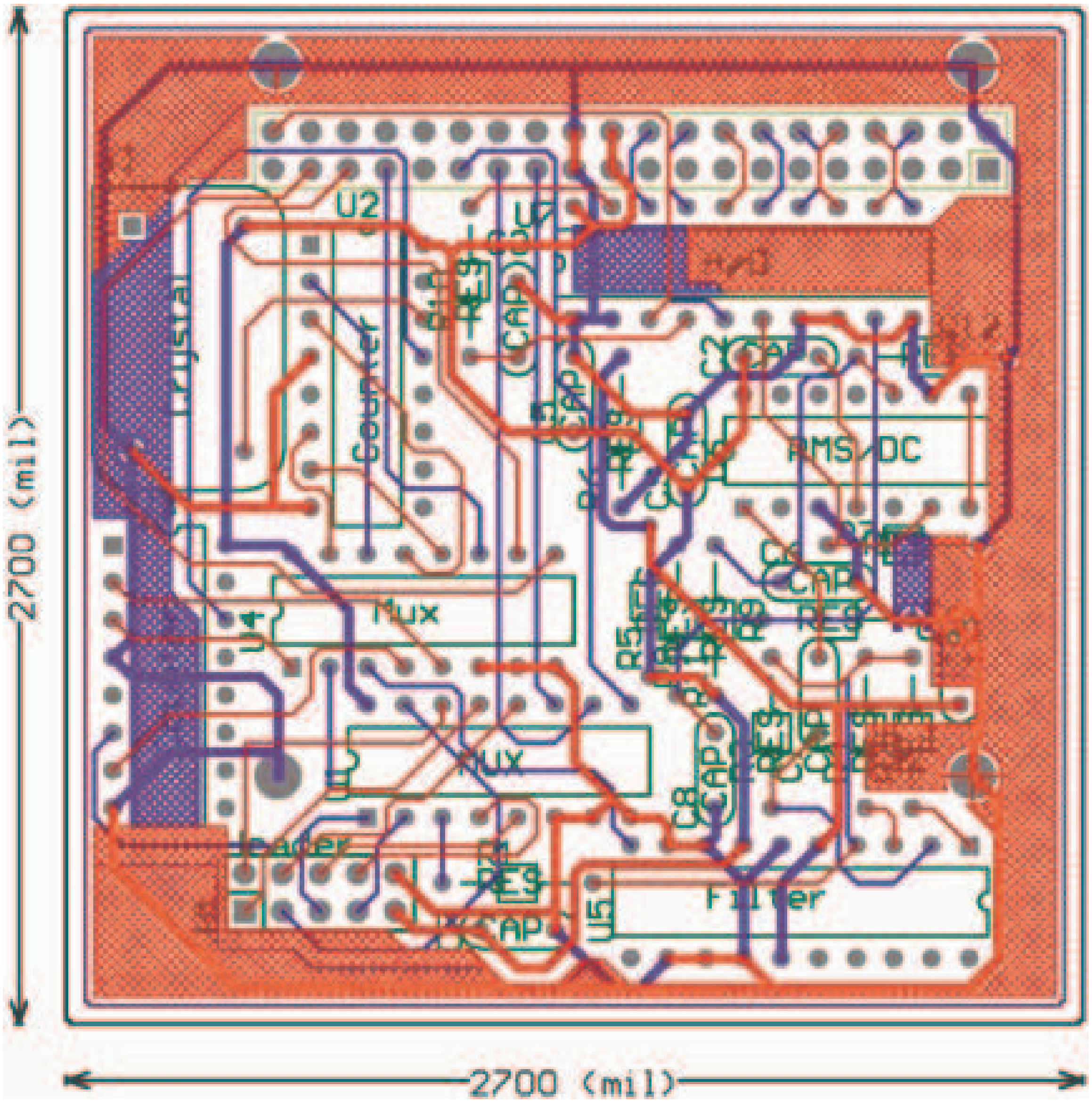


Figure 1 — Final Interface PCB Design

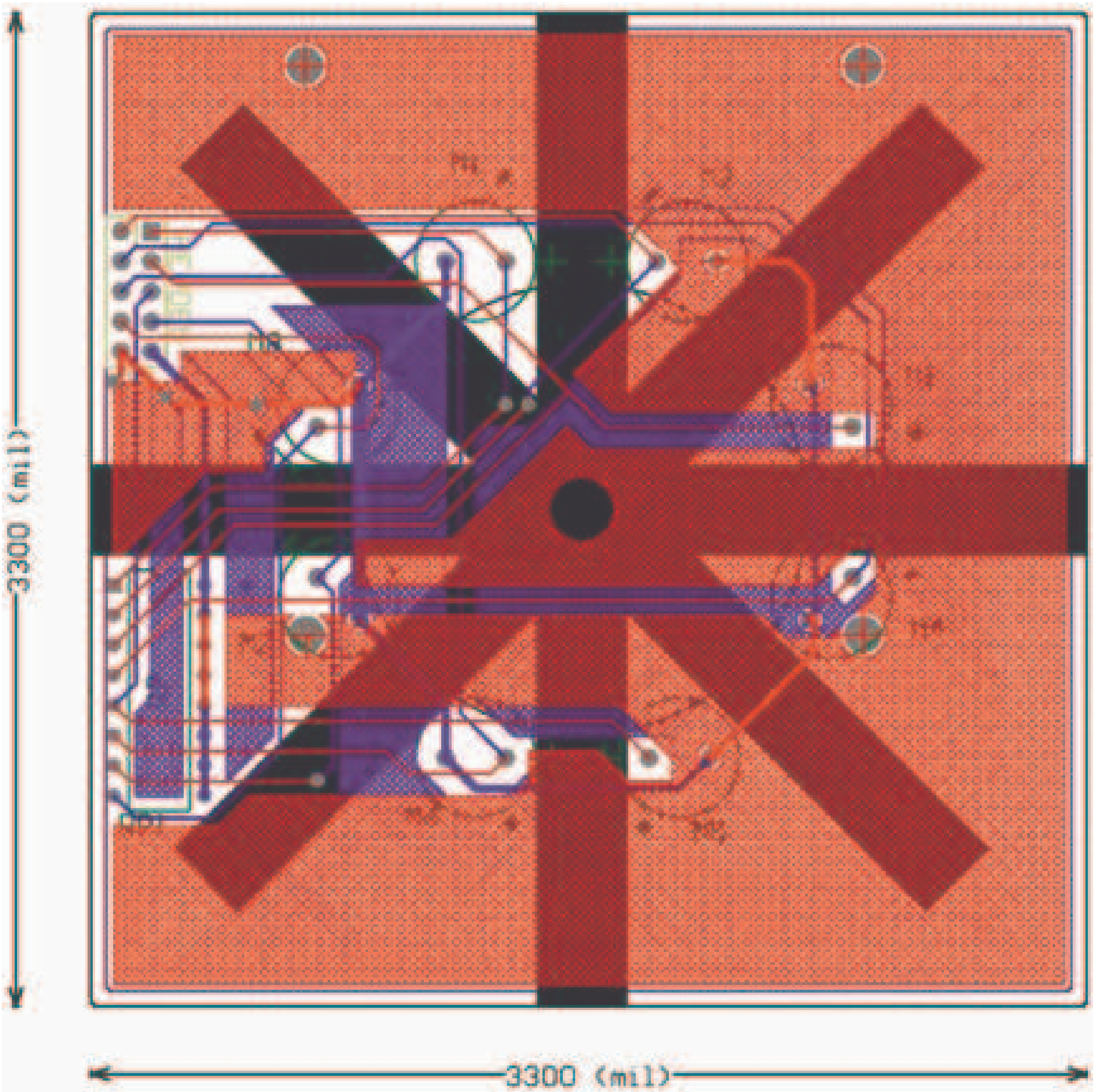


Figure 2 — Final Microphone PCB Design

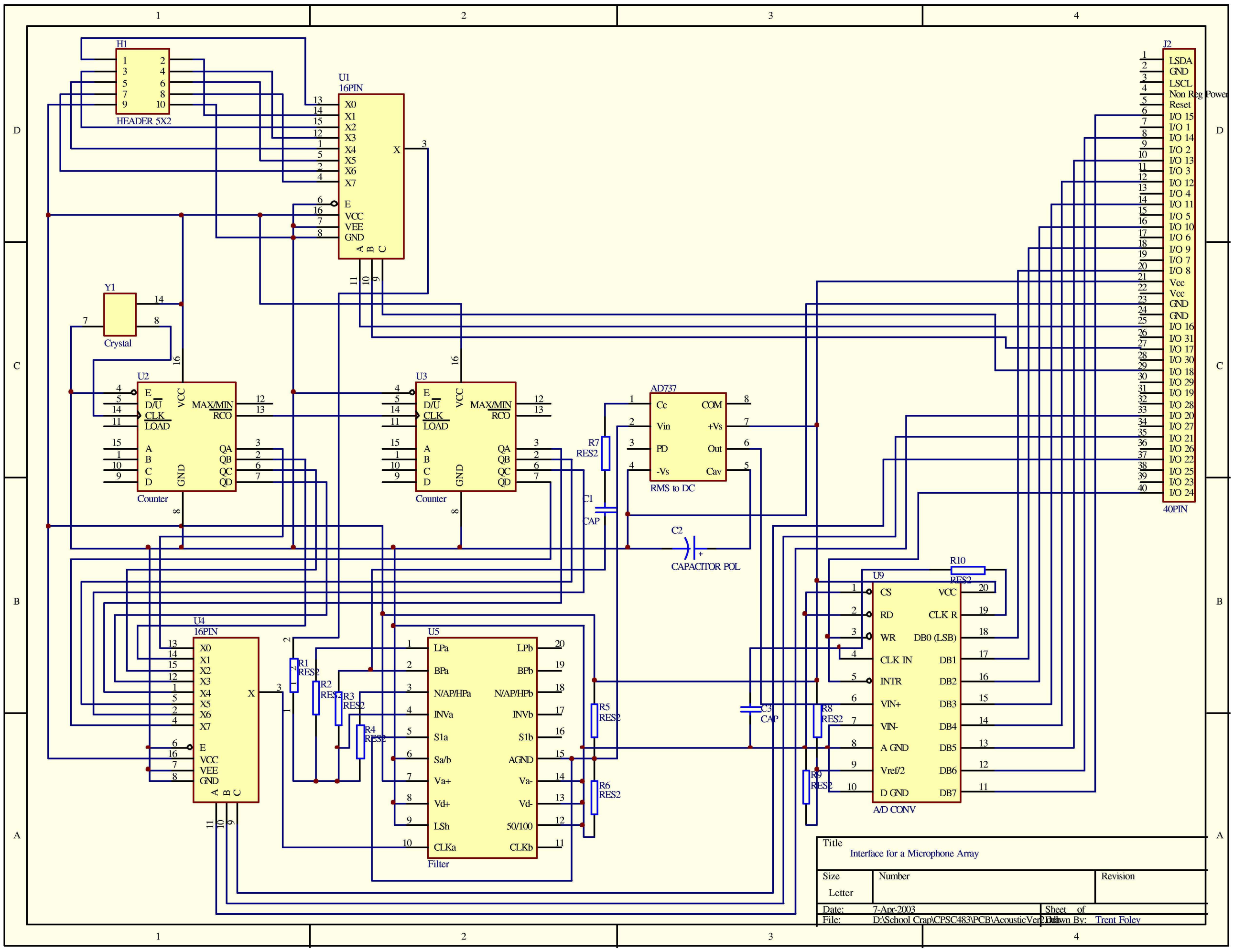


Figure 3 — Final Schematic

19-0824; Rev 2; 3/96

MAXIM

True RMS-to-DC Converters

MX536A/MX636

General Description

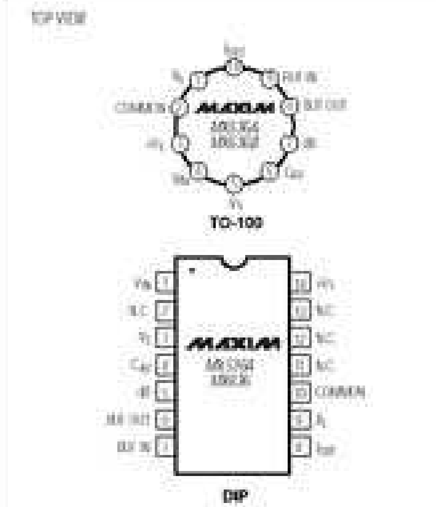
The MX536A and MX636 are true RMS-to-DC converters. They feature low power and are designed to accept low-level input signals from 0 to 7V_{RMS} for the MX536A and 0 to 200mV_{RMS} for the MX636. Both devices accept complex input waveforms containing AC and DC components. They can be operated from either a single supply or dual supplies. Both devices draw less than 1mA of quiescent supply current, making them ideal for battery-powered applications.

Input and output offset, positive and negative waveform symmetry (DC reversal), and full-scale accuracy are laser trimmed, so that no external trims are required to achieve full rated accuracy.

Applications

Digital Multimeters
Battery-Powered Instruments
Panel Meters
Process Control

Pin Configurations



Pin Configurations continued at end of data sheet.

Features

- True RMS-to-DC Conversion
- Computes RMS of AC and DC Signals
- Wide Response:
  2MHz Bandwidth for V_{RMS} > 1V (MX536A)
  1MHz Bandwidth for V_{RMS} > 100mV (MX636)
- Auxiliary dB Output: 60dB Range (MX536A)
  50dB Range (MX636)
- Single- or Dual-Supply Operation
- Low Power: 1.2mA typ (MX536A)
  800µA typ (MX636)

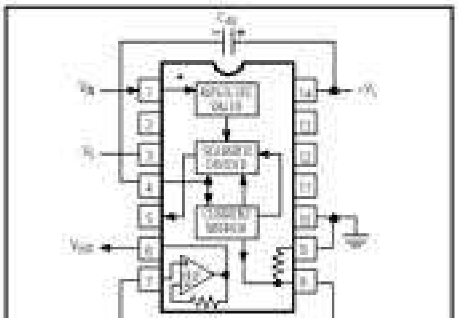
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MX536AJC/D	0°C to +70°C	Dice**
MX536AJCWE	0°C to +70°C	16 Wide SO
MX536AJD	0°C to +70°C	14 Ceramic
MX536AJH	0°C to +70°C	10 TO-100
MX536AJN	0°C to +70°C	14 Plastic DIP
MX536AJQ*	0°C to +70°C	14 CERDIP
MX536AKCWE	0°C to +70°C	16 Wide SO
MX536AKD	0°C to +70°C	14 Ceramic
MX536AKH	0°C to +70°C	10 TO-100
MX536AKN	0°C to +70°C	14 Plastic DIP
MX536AKQ*	0°C to +70°C	14 CERDIP
MX536ASD	-55°C to +125°C	14 Ceramic

Ordering Information continued at end of data sheet.

* Maxim reserves the right to ship ceramic packages in lieu of CERDIP packages.
** Dice are specified at T_A = +25°C.

Typical Operating Circuits



Typical Operating Circuits continued at end of data sheet.

MAXIM ______ Maxim Integrated Products 1

For free samples & the latest literature: http://www.maxim-ic.com, or phone 1-800-998-8800. For small orders, phone 408-737-7600 ext. 3468.

Figure 4 — RMS-to-DC Conversion

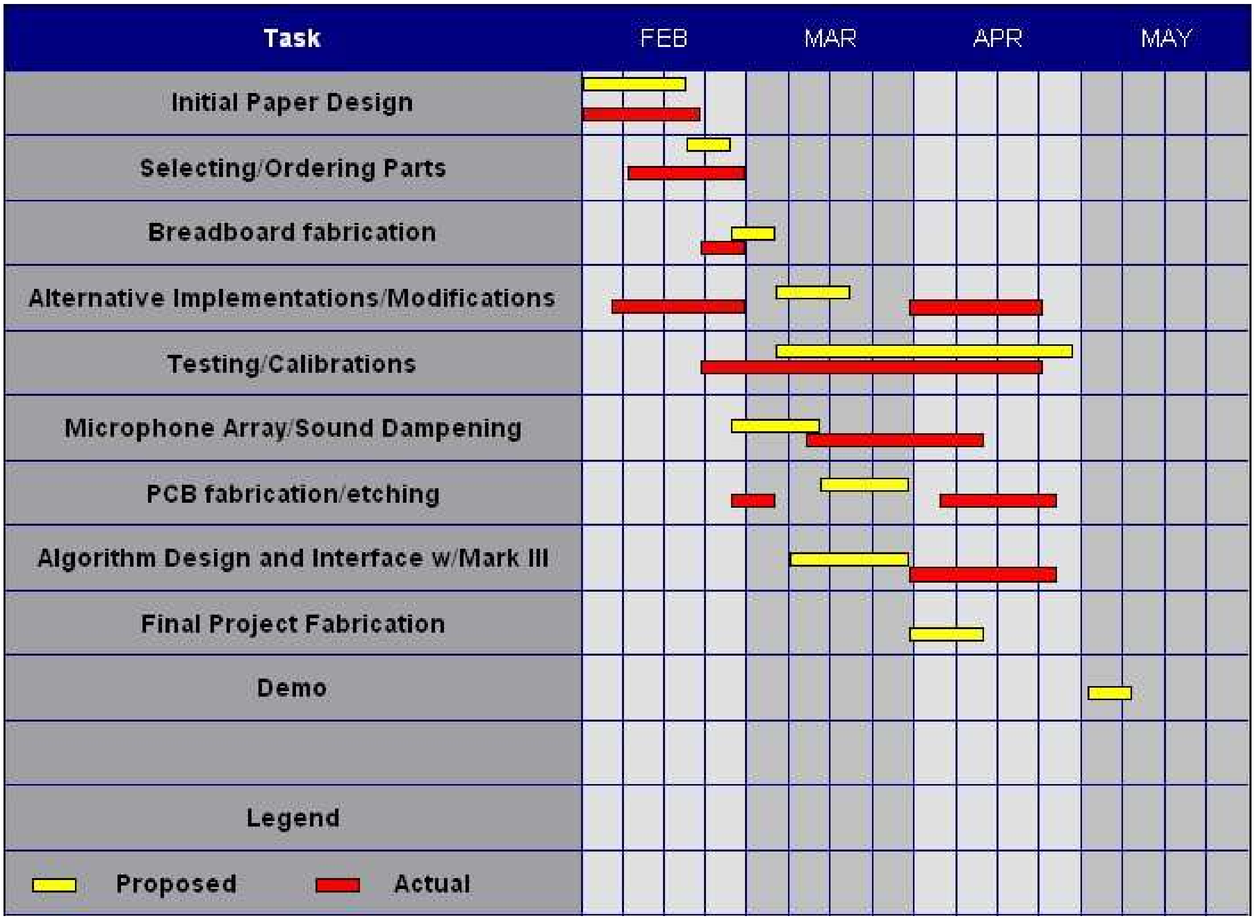


Figure 5 — Gantt Chart

Part Type	Part Number	Quantity	Price	Total
1 MHz Oscillator	MX045	2	$ -	$ -
4-bit Counters	74LS191N	4	$ -	$ -
8:1 Analog Multiplexer	MC74HC4051A	4	$ -	$ -
RMS-to-DC Converter	MX536A	2	$ -	$ -
Switched Capacitor Filter	LMF100	2	$ -	$ -
4.7k Resistor Pack		2	$ -	$ -
A/D Converter	ADC0801	2	$ -	$ -
Microphones	WM-65A103	44	$ 1.83	$ 100.52
Dynamat Sound Dampening Material		1	$ 21.64	$ 21.64
Mark III Robot		1	$ 98.00	$ 98.00
Mark III Robot Upgrade		1	$ 30.00	$ 30.00
LED Display	276-0081	1	$ 3.24	$ 3.24
Piezo Buzzer	273-0059	1	$ 3.24	$ 3.24
Flux	640-0021	1	$ 2.70	$ 2.70
Cleaner w/ brush	540-4327	1	$ 11.90	$ 11.90
Various Discrete Components		1	$ 4.82	$ 4.82
PCB Fabrication		1	$ 150.00	$ 150.00
DIP Switch	275-1301	1	$ 2.48	$ 2.48
10k Resistor Pack		1	?	?
Plexiglass		1	?	?
Various Discrete Components		1	?	?
Various Discrete Components		1	?	?
Standoffs		1	?	?
Ribbon Cables, etc.		1	?	?
	Current Estimated Total:			$ 428.52

Table 1 — Current Price Breakdown