Senior Project Description
Introduction:

Noise pollution is one of many harmful sources to humans. A sound level of 130dB or more can bring immediate hearing damage to a person. If a person is exposed to a sound level of 90 dB or more for various hour durations, hearing damage can occur, as shown below:

<table>
<thead>
<tr>
<th>Hours Duration Per Day</th>
<th>Sound Level (dB) Slow Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1.5</td>
<td>102</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>.5</td>
<td>110</td>
</tr>
<tr>
<td>0.25</td>
<td>115</td>
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</table>

For people who need to work with machinery, it is very important that the work environment is under noise control. Because of this, I propose to build a decibel meter, which will be specially made for measuring the noise level in areas where machinery is located. Along with a LCD display for a dB reading, there would be LED display to indicate the level of danger.
Fig 1 Estimated dimension of the final product

Functional Description:

Hardware:

The maximum estimated dimensions of the final product would be 8 in x 10 in x 3 in as illustrated in Figure 1. All the user interfaces will be on the top of the device. Figure 2 is a functional hardware diagram. The microphone has sensitivity between –44dB to 4dB, and the signal received will need to be pre-amplified before filtering. Then the signal will go through a C-weighting (band pass filter), which limits the frequency to a range of 32-10,000 Hz. Before converting to a digital signal, the filtered analog signal needs to be amplified in order to increase the sensitivity of the device. Because the signal range will be between 90dB to 150 dB, the 10 bits A/D converter in the HCS12 is not enough to
convert this large range of signal. As a result, a log Amplifier will be needed.

**Functional hardware description:**

HCS12 has 25MHz bus frequency, so it is much faster than HC12; thus, it is more capable to support a constant data processing and storage. Some of the program code will be written in C language. One of the disadvantages of C language is code-size efficiency, but HCS12 will have enough space for the code because it has 256k Flash EEPROM, 12k EEPROM, and 4k EEPROM. Most of the code will be stored in the 12k EEPROM. RAM will be used to store the highest peak value of the sound level and some parameters to calculate the sound level. Therefore, 1k RAM should be enough. One A/D converter will be used to convert the voltage to the digital signal. There will be a low voltage detection reset circuitry connected to the reset, and a crystal is used as a resonance device for the oscillator. PWM on Port P (PP0) will be used to write data to the LCD module. The I/O lines on Port T (PT 0-3) will be used to interface the pushbuttons. The LEDs will use 6 I/O lines on Port B (0-5). For the power supply, a 9 DVC Wall transformer with maximum current 1A will be used.
Software requirements:

MicroC/OS, a real-time preemptive multitasking kernel, will be used to manage the tasks in this device. It allows the priority tasks to have a faster response time. The program code will be written in both C language and assembly language. Below are some brief module descriptions.

Module description:

Display: This module will write data and update the data to the LCD. It also controls the LED display
Kernel: MircoC/OS will be used to manage the system tasks.

Button: This module will detect which button has been pushed and debounce the pushbuttons

Input: This module will control how often the input data is sampled.

Conversion: This module will convert the data to decibel

User interface:

Figure 3 below showed the configurations of the LEDs. There will be 6 LEDs in the meter.

One of the two LEDs will turn on if the sound level is below 90 dB or above 150 dB (for the sound level that fall on these two ranges, there will not be readings on LCD). There will also be different LED displays for dB readings between 90 to 95 dB, 95 to 102 dB, 102 to 115 dB, and above 115 dB.

![LED displays diagram]

Fig 3 LED displays diagram

The meter will have 4 push buttons as shown in Figure 4. The “Slow” button will allow the LCD to display the average noise level. If the “Fast” button is pushed, LCD will display the so called “peak” noise level (it has much shorter average time than slow
response, thus it is much closer to the current sound level); this meter will be able to store
the highest peak noise level during a time interval, which can be set by a “Start/Stop”
button. When this button is pushed once (start), the highest stored peak level is reset. The
meter will start to compare the sound level and the higher peak sound level will be stored.
When the button is pushed again (stop), it will stop comparing, and the stored highest
sound level is fixed. By pushing the “Peak” button, this highest peak reading will be
shown on the LCD display. Figure 5 is a state diagram, which shows the display states
when each different button is pushed.

Fig 4 Push buttons diagram
Fig 5 State diagram of LCD display

Development plan:

Schedule:

-Winter break: Design preamp and filter circuits

-Winter Quarter 2004

Week 1: Design Amplifier circuits

Week 2: Design Amplifier circuits
Week 3: Design external A/D converter

Week 4: Design external A/D converter

Week 5: Design Power supply

Week 6: Set up the LCD to the driver

Week 7: Begin software design

Week 8: Write/ modify Kernel module

Week 9: Write/modify Kernel module

-Spring Quarter 2004

Week 1: Write/modify display module

Week 2: Write Conversion module

Week 3: Write Conversion module

Week 4: Write/ modify module for the button module

Week 5: Write/ modify input module

Week 6: Integrate software

Week 7: Integrate software with the hardware

Week 8: Test/ calibrate the final product

Week 9: Test/ calibrate the final product and code reviews

Week 10 Demonstration
Development hardware and software:

In the early analog designs stages, most circuit building and testing will be held at lab ET 338. Once the software designs start, project will be developed at lab ET 340. The resources in these two labs such as power supplies, soldering irons, oscilloscope, will be used for the project development. Pspice and Tina will be used for analog design. Major program code will be written in C language, so CodeWright system, Intro-CODE, and Noral BDM Flex debugger will be needed in the software development.

Demonstration:

This device has to be tested and demonstrated in an area that would have a sound level of 90dB or more. I will have a boom box to produce the sound with sound proofing material around it. The microphone will be put near the boom box while the body of the DB meter stays outside the sound proofing area. If time allows, all parts will be soldered together and be put into a case with the microcontroller development board.

Electrical Specification:

Project specification:

Resolution: 0.1 dB

Display range: 90 to 150 dB
BW: 32-10,000 Hz

Power specification:

AC power: Wall transformer 120 VAC in, 9VDC and 5VDC

Worst case power dissipation: 1014 mW

Special environmental requirement:

Temperature range: 10-60°F

PCB size limits:

Length < 5 in

Width < 5 in

Height < 1 in
<table>
<thead>
<tr>
<th>Part #</th>
<th>Description</th>
<th>Quantity</th>
<th>Max current</th>
<th>Source</th>
<th>Lead time</th>
<th>Price</th>
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