Signal Processing Module

The signal processing module consists of analog to digital converter and the microcontroller. The signal processing module must receive an analog voltage signal from the signal acquisition module and ultimately determine the likelihood that the analog signal exhibits pneumonia characteristics. This likelihood must be transferred to the user interface module. Moreover, the signal processing module must be capable of being triggered by the user, so that audio data acquisition can be synchronized to the moment that the patient is instructed to begin breathing deeply. In order to implement the above functionality, an analog-to-digital converter (ADC) and microcontroller are necessary.

Preliminary calculations performed for the design of the device suggest a required memory capacity of 440KB for the microcontroller. In addition, these calculations assumed a sample bit size of 10 bits/sample. Thus, a 10-bit ADC is required. The ADC must also be capable of the desired 8,000Hz sampling rate, therefore the number of digital and analog I/O channels must be determined. From Figure 1, it is apparent that the microcontroller must receive one analog input from the microphone (mono audio) and one digital input from the "recording switch." The only outputs necessary are used for controlling the LED display screen (see next section). In addition, 4 bits are necessary to uniquely identify all 10 values from 0-9 (three bits are insufficient because 2^3 is less than 10). In order to display two independent digits, the required number of microphone digital outputs is 8 (obtained using: 4 bits * 2 digits). All of this information is summarized in Table 1.

Parameter	Value
ADC Bit Size	10
ADC Sampling Speed	8,000 Hz
Microcontroller Memory	> 440 KB
Microcontroller Analog Inputs	1
Microcontroller Digital Inputs	1
Microcontroller Digital Outputs	8

Table 1: Parameters related to the signal processing module of the device.

Based on the information presented in the table, the *Texas Instruments MSP430 Mixed Signal Microcontroller* was chosen to implement the signal processing module. It has an in-built 10 bit ADC as well as 512 KB of flash memory. More than enough digital and analog I/O pins are available, and the entire package has remarkably low power consumption.

Once the signal is processed on the microcontroller, the data must be output to the display screen. This is accomplished through *CMOS BCD-to-7-Segment LED Latch Decoder Drivers* which will convert the output of the microcontroller into 7 outputs which are then used by the screen to display the correct percentage.

.