

## ECG Monitor - Abstract

### Introduction:

This project deals with an application of H3687 from Renesas H8 series of processors in the Medical field to record ECG.

The electrocardiogram, or ECG (also known as EKG, abbreviated from the German word), is a surface measurement of the electrical potential generated by electrical activity in cardiac tissue. Current flow, in the form of ions, signals contraction of cardiac muscle fibers leading to the heart's pumping action. The study of this electrical signals can help in determining many abnormalities related to the heart's function. The following is a sample of how an ECG looks like.

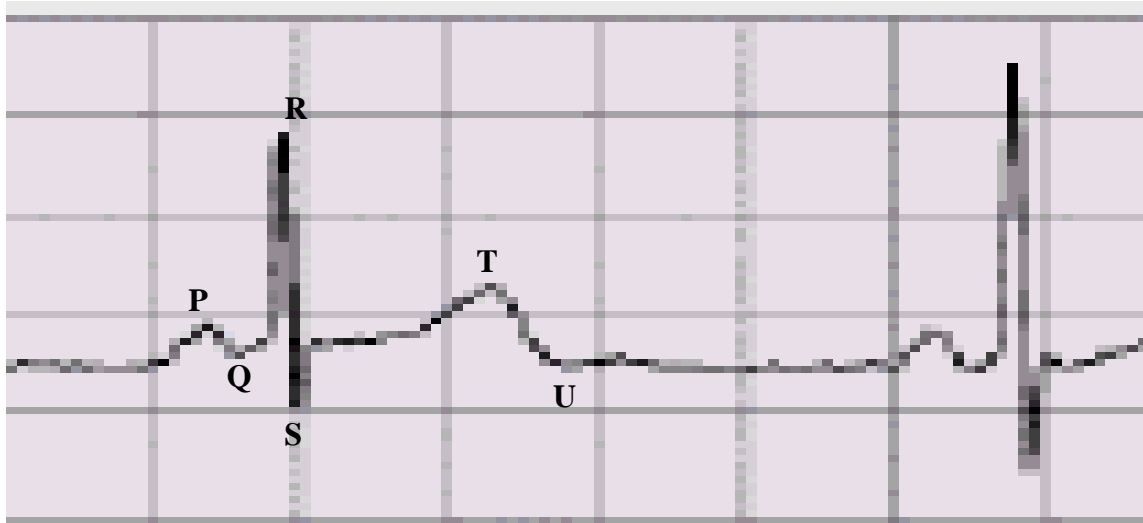
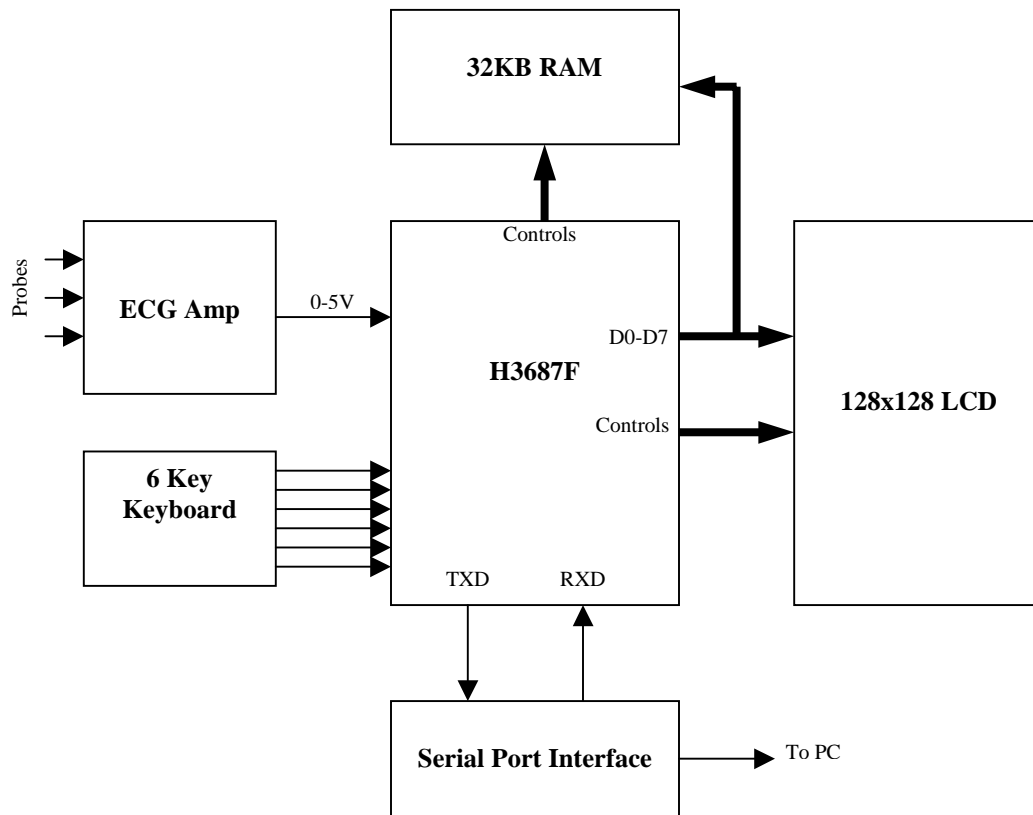


Figure – 1 A typical ECG waveform

By studying the time between different points P, Q, R, S, T and U and the variations in these times between successive beats many diseases with the heart can be detected.

The ECG monitor described records 4 different ECG signals and can display the ECG waveform on a 128x128 Graphical LCD display. By changing the Time-base, the ECG waveform can be studied in detail. The monitor also has software for beat detection incorporated that also displays the Heart Rate on the screen. The recorded ECG pattern can be uploaded to a PC through a serial port and the signal can be displayed on the PC. Software written in VB receives the data and displays the ECG waveforms of all the 4 channels on the screen. The software can be modified to do advanced analysis of the ECG data like QRS detection, arrhythmia detection etc.

**Block Diagram:**

**ECG Amp:** This circuit amplifies the differential ECG signal introduces a small level shift to bring the negative signals to the positive side and feeds the input of ADC of the H3687. This circuit has a INA126 differential Amplifier followed by a High Pass Filter, a non-inverting amplifier with a variable gain and finally a level shifter that adds a 1V offset to the amplified ECG signal.

**6 Key Keyboard:** This circuit has 6 keys that are used to control the ECG monitor. The Keys are Start/Stop Recording, Send Data to PC, Scroll Left, Scroll Right, Select Channel and Select Time-base.

**32KB RAM:** This circuit is 62256, a 32KB static RAM. This is used to store the recorded ECG data at 8KB per channel. As the ECG is sampled at 1ms intervals each channel can store 8.192 seconds of ECG signal per channel.

**Serial Port Interface:** This circuit is built around the MAX232 Serial Interface IC. This circuit is used to send the recorded data to the PC. This circuit also is used to program the 3687 on board.

**128x128 LCD:** This is a 128x128 Graphical LCD display based on the KS0108 controller. This displays the recorded ECG waveform as well as other information like Channel number, Time-base and calculated Heart rate.

**H3687:** The Heart of the ECG Monitor is the H3687 controller from Renesas. The controller performs the following operations.

1. Accepts the Analog signal from the ECG Amp and digitizes it and stores it in the RAM.
2. Reads the Keyboard and performs the requested operations like Record, Select Channel, Select Time-base, Scroll the ECG signal on screen and Send Data to PC etc.
3. It generates the D0-D7 data bus for the RAM and LCD display.
4. It generates CS1, CS2, CS3, CS4, LCD\_E, LCD\_RESET signals for controlling the LCD.
5. It generates A0-A14, CS0, RD, WR signals to control the RAM.
6. It communicates through the MAX232 to send the recorded data to PC.

### **Operation and Control:**

#### **The Keyboard Panel:**

1. **Channel Select Key:** This key is used to select the channel to which the ECG data has to be recorded. Pressing this key changes the Channel number from 1 to 4. After 4, the number loops back to 1.
2. **Time-base Select Key:** This key is used to select the time-base (time / pixel). This is useful to study the recorded waveform in detail. This can be compared to Zoom in and Zoom out functions. Pressing this key changes the Time-base between 1ms, 2ms, 5ms, 10ms and 20ms.
3. **Scroll Left Key:** This key is used to scroll the displayed waveform to the Left.
4. **Scroll Right Key:** This key is used to scroll the displayed waveform to the Right.
5. **Start/Stop Recording:** This key is used to start recording the ECG data to the selected channel.
6. **Send to PC:** This key is used to send the recorded data to the PC.

#### **Operation:**

Stick the GND electrode either to the right forearm or right leg. Stick the negative electrode to the right chest. Stick the positive electrode to the left chest at the desired location. The positive electrode can be shifted to 4 places and 4 different waveforms can be recorded.

Select the Channel number using the Channel Select key. The selected channel number is displayed on the screen. Press the Start/Stop Recording Key. The controller displays "Recording" on top half of the screen while recording takes place. After 8.192 seconds (After 8192 samples), the recording is completed and the recorded wave is displayed on top half of the LCD Screen. The waveform can be viewed using the Scroll Left and Right keys. If you want to view the details of a single beat, then position the beat pulse at the Left of the Screen using the Scroll keys and then using the Time-base Select Key, change the time-base to 1ms, 2ms or 5ms to Zoom into the beat pattern. The default time-base is 10ms.

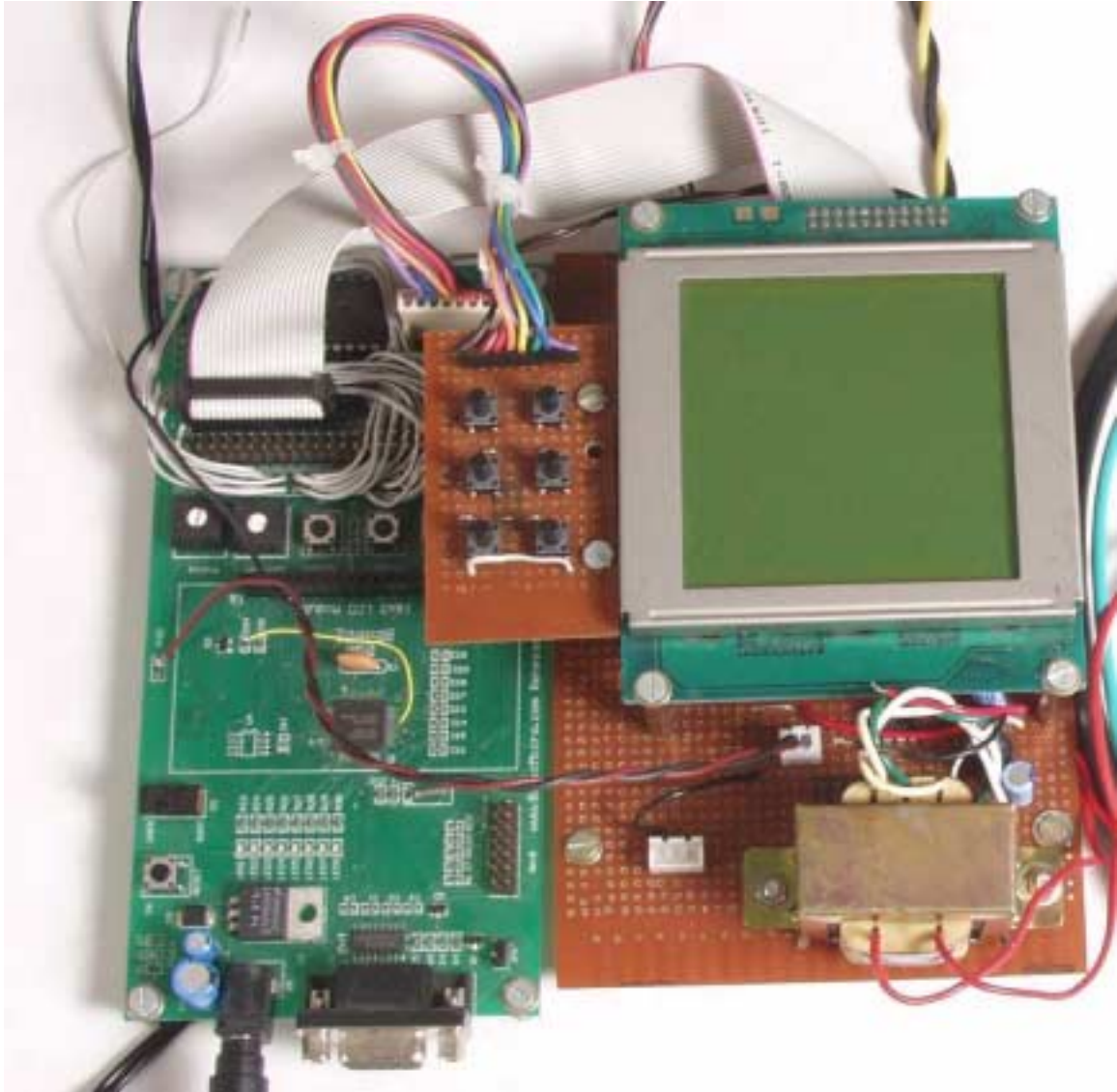
Now stick the positive electrode to other locations on the left chest and selecting the Channel Record the other waveforms too. When all the 4 channels have been recorded, pressing the Channel Select key will display the respective waveform and will also display the calculated Heart beat rate.

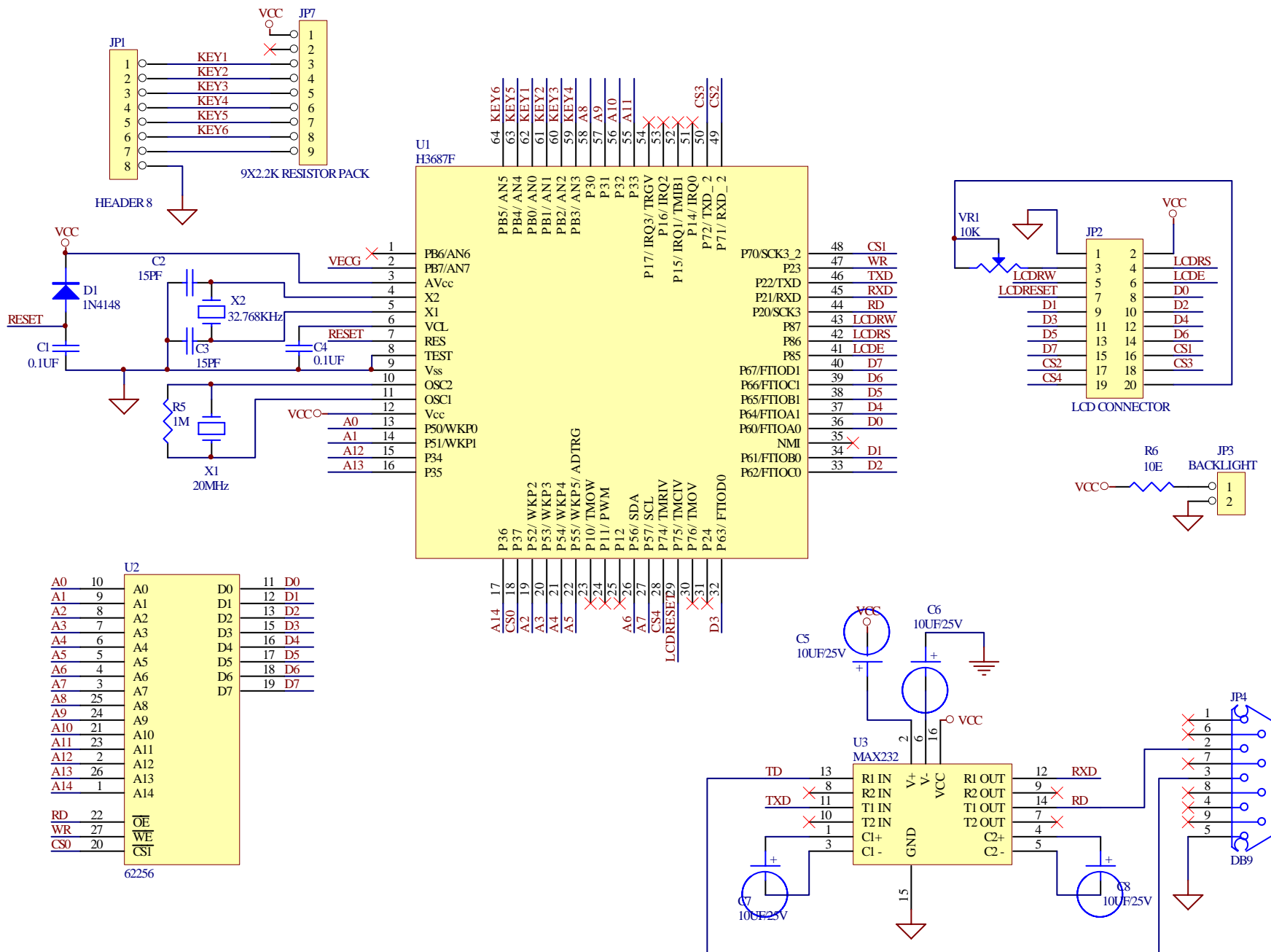
Now connect the monitor to the PC and start the ECG Monitor Program. Press the Send to PC key. The monitor prompts "Sending Data To PC" at the bottom of the display. When the data transmission is complete, the ECG waveforms of all the 4 channels are displayed on the PC Screen.

**Code Snippet:**

The following part of code does the recording of ECG wave to the RAM. On completion, the waveform is displayed on the LCD.

```
// If recording has been started, check for ADC complete flag.
// If ADC result is available, then write to RAM
if (Flags & FlagRecording)
{
    if (AdcCompleteFlag)           // Is result available
    {
        AdcCompleteFlag = ClearCompleteFlag;           // Clear ADC flag
        AdcResult = WindowIntegrator((AdcRegisterA>>8),1);
                // If the last RAM page location has not been reached, write to RAM
        if (Offset < 8192)
        {
            WriteToRam((unsigned char)AdcResult,(Offset+RamPageAddress));
            Offset++;
        }
        // If RAM Page is full, then clear the Recording flag and display
        // the recorded ECG data on screen
        else if (Offset >= 8192)
        {
            Flags &= ~FlagRecording;// Clear Recording Flag
            TimerStop = 1;
            TimerEnable = 0;           // Stop the Timer
            Offset = 0;               // Initialize RAM Page offset address
            DisplayEcg();             // Display the recorded ECG data
        }
    }
}
}
```





# ECG Monitor

